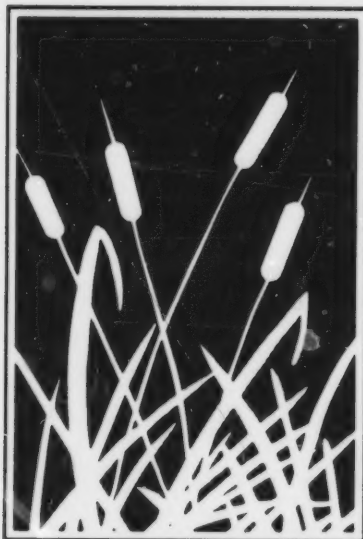


WETLANDS ARE NOT WASTELANDS



A JOINT PROJECT BETWEEN

WILDLIFE HABITAT
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WETLANDS ARE NOT WASTELANDS

**APPLICATION OF WETLAND EVALUATION METHODS
TO THE COWICHAN ESTUARY, BRITISH COLUMBIA**

Pacific and Yukon Region Pilot Study

March 1989

Report

4

**Prepared for Sustainable Development Branch,
Canadian Wildlife Service and
Wildlife Habitat Canada**

**By Alan Ferguson, Regional Consulting Ltd., Vancouver
Gary Holman, Marvin Shaffer & Associates Ltd., Vancouver
Ron Kistritz, R.U. Kistritz Consultants Ltd., Vancouver**

PREFACE

This pilot study is part of a multi-year project being led by the Sustainable Development Branch, Canadian Wildlife Service and Wildlife Habitat Canada, with the assistance of CWS Regional Offices. The overall goal of the project is to demonstrate that wetlands are not wastelands.

The objective of the project is to develop and pilot test evaluation methodologies in order to identify current or new approaches which best show and incorporate the sustainable resource values of wetlands. Based on these activities a manual will be produced for use by provincial and local land-use planners and officials in the evaluation of wetlands and wetland change proposals.

Current methods of evaluating many resources inadequately portray their true environmental and economic value to society based on the functions they support. This is particularly true of wetlands, which, when threatened with conversion to other uses or with degradation, have been virtually impossible to adequately value using the most common current methods of evaluation such as benefit-cost analysis. As a result, many good wetlands have been altered to other uses simply because their value to society cannot be adequately demonstrated and because comparative evaluation methodologies automatically favour other short-term, high-value uses of the land resource.

There is, however, an increasing body of scientific literature identifying the importance of the functioning of wetlands in their natural state in providing for specific benefits to society. These functions include water storage, sediment retention and nutrient recycling, as well as the provision of increased biomass energy, biological diversity and fish and wildlife habitat. Likewise, there is a recognition of the value of these functions to society for wildlife and nature conservation, active and passive recreation, commercial plant and animal production, extraction, risk reduction, research and education, and aesthetics or landscape diversity, among others, by various governmental and other agencies. This recognition in turn has prompted the development of conservation-oriented initiatives.

In response, this project has focussed on the development and testing of alternative procedures and evaluation methodologies which more adequately portray the true values of wetland resources. To do this, it is necessary to evaluate, adapt and develop methodologies, pilot test them on particular wetland problems, involve a wide spectrum of involved groups or individuals in the verification of the validity of such methodologies, and ultimately produce a manual backed by a broad consensus which can act as a guide to provincial and local land-use planners and decision-makers for appropriate evaluation of wetlands when they are involved in a planning decision process. The major steps in the project are listed below:

- a) Based on a workshop focussing on alternative methods of evaluating renewable resources (Manning and Cox, 1986), a short list of potential approaches to the evaluation of wetlands has been developed. These include:

1. an approach based on willingness-to-pay for wetland values and functions;
 2. an opportunity cost approach to be applied to measurable wetland values and to the proposed alternate use; and
 3. a cumulative impact approach synthesizing a broader range of social goals and objectives than those generally encompassed by the term "economic".
- b) The three alternative methodological approaches have been described in detail and the conceptual context of each is provided in the report "Wetland Evaluation: Methodology Development and Pilot Area Selection" (Bardecki, 1987).
- c) The three selected methods have been tested in four pilot studies across Canada - the current stage of the project. The four case study areas are the Minudie Dykelands, Nova Scotia; the Greenock Swamp, Ontario; the Prairies Pothole region, Saskatchewan; and the Cowichan Estuary, British Columbia. The sites have been chosen to allow for testing applicability of the methods using a variety of types of wetlands. This report provides the results of one of the pilot studies.
- d) Based on the results of the case studies a draft manual will be developed for application to the planning of the use of wetlands. It will include a discussion of the functions and values of wetlands, and the presentation of a range of approaches and methodologies appropriate to the evaluation of wetland values and their incorporation into the planning decision process. An expert committee will evaluate the pilot study results and advise on the particular directions for the manual and its contents.
- e) A conference of involved individuals from the planning community, wildlife community, agriculture, etc., will be held to engender broad based support for the manual as an appropriate method to be applied whenever wetlands use and management are in question. At a minimum, the manual should serve as a broadly based reference document for use by all decision-makers dealing with wetland conservation or conversion.

ACKNOWLEDGEMENTS

Overall, management of the project has been provided by a National Steering Committee comprised of Ken Cox, Wildlife Habitat Canada, and Edward W. Manning, Wayne Bond, Gerry Lee, and Fern Filion, Canadian Wildlife Service. Funding for the pilot studies has been provided by Wildlife Habitat Canada and the Sustainable Development Branch of the Canadian Wildlife Service.

Management of the individual pilot studies (except Greenock Swamp) has been undertaken by the respective regional office of the Canadian Wildlife Service. Scientific authorities for the pilot studies were:

Minudie Dykelands

Joe Arbour, CWS, Atlantic Region

Prairie Potholes

Dave Gierman, CWS, Western and Northern Region.

Cowichan Estuary

Ken Redpath, CWS, Pacific and Yukon Region.

EXECUTIVE SUMMARY

The purpose of this study is to demonstrate the application of three wetland evaluation methods related to willingness-to-pay, opportunity cost and cumulative assessment, using the Cowichan Estuary on Vancouver Island as a case study. The study described the characteristics and distribution of wetland habitat types within the estuary. The impact of two hypothetical development projects on the physical, biological and socio economic "functions" performed by the wetlands and the related wetland "products", particularly fish, birds, recreation and water quality are assessed in detail. A habitat rating system is used to ascribe the wetland products to various habitat types and areas within the estuary.

The wetland habitat types are prioritized according to specific criteria considered important for each of the four wetland functions related to fish, birds, recreation and water quality. The habitat rating system assesses, firstly, the relative capability (high, moderate, low) of habitat types to support the wetland functions and secondly, the relative scarcity of the habitat types (< 5%, 5-20%, > 20% of total wetland habitat). Total ratings are then generated for each habitat type and wetland product. These ratings are subsequently used to determine the distribution of biological and economic values within the estuary.

Two development scenarios related to port expansion and agricultural development were formulated in order to test the evaluation methods. The willingness-to-pay and opportunity cost methods were incorporated into a benefit-cost analysis of the potential projects. The cumulative assessment method used a diverse set of criteria and indicators which reflect the variety of biophysical, economic and social attributes of the wetland.

The results of the willingness-to-pay survey represent typical values associated with the wetland. Local residents (within 15 mile radius) and non-local residents (Victoria, Nanaimo) were asked about their use and valuation of the wetlands. The interview respondents (42) generated an estimated 1,152 visits annually to the estuary and valued these visits at an average of \$17.70 per visit. Total local user value is approximately \$681,500 per year. The total local preservation value is estimated at \$1.28 million per year (\$50 average preservation value times the local area population).

Total fisheries value (commercial, sport, Native) attributable to the Cowichan estuary is estimated at \$54.6 million (present value in 1989 dollars @ 8%). The present value of hunting activities is \$360,000 - \$500,000. Nature and wildlife viewing activities, involving an estimated 4,200 visitor-days per year, represent a present economic value of \$575,000. Additional, unquantified, social benefits are related to ecological values, scientific research and educational functions. Other economic values for potential water quality treatment of sewage effluent could be derived from the wetlands in the future.

The total resource value attributable to the functions of the estuary is estimated at \$55.6 million in present value terms, or an average of \$114,000/hectare.

The resource losses associated with potential port expansion and agricultural reclamation were estimated by determining the direct effect of development on total wetland habitat rating and by assuming a proportional loss in total economic value.

The port expansion scenario would result in a loss of 3.2% of total fish habitat rating, 2.6% of total bird habitat rating and 1.5% of total recreation habitat rating. The agricultural reclamation scenario would result in a loss of 1.4% of total fish habitat rating, 4.5% of total bird habitat rating, 4.2% of total recreation habitat rating and 6.5% of water quality renovation habitat rating. The resource loss related to commercial and recreational fisheries represent the largest effects, involving a present value loss of \$1 million for port development and \$450,000 for land reclamation.

The cumulative assessment provided a compendium of indicators of project impact, including physical effects, habitat effects, and effects on fish and wildlife populations, recreation uses, economic values and other indicators.

The three methods together provided a comprehensive evaluation of the impacts of the potential development scenarios on the functions and values of the Cowichan estuary wetlands. They were particularly effective in addressing the distribution of these wetland functions and values and offering a framework for evaluating the marginal impact of development.

It is recommended firstly, that a preliminary screening mechanism be established for project evaluation prior to detailed studies. Secondly, a structured method, such as the habitat rating method used in this study, is needed to assess the incremental and cumulative effects caused by alienation and degradation of wetland. Thirdly, standardized economic values could be produced for various types of wetlands and used to provide approximate economic data for evaluating specific projects which are proposed for wetland locations. Finally, wetland management policies and plans are an important complement to wetland evaluation methods which provide the necessary direction and guidance for minimizing the loss and degradation of wetlands in Canada.

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1.0 INTRODUCTION

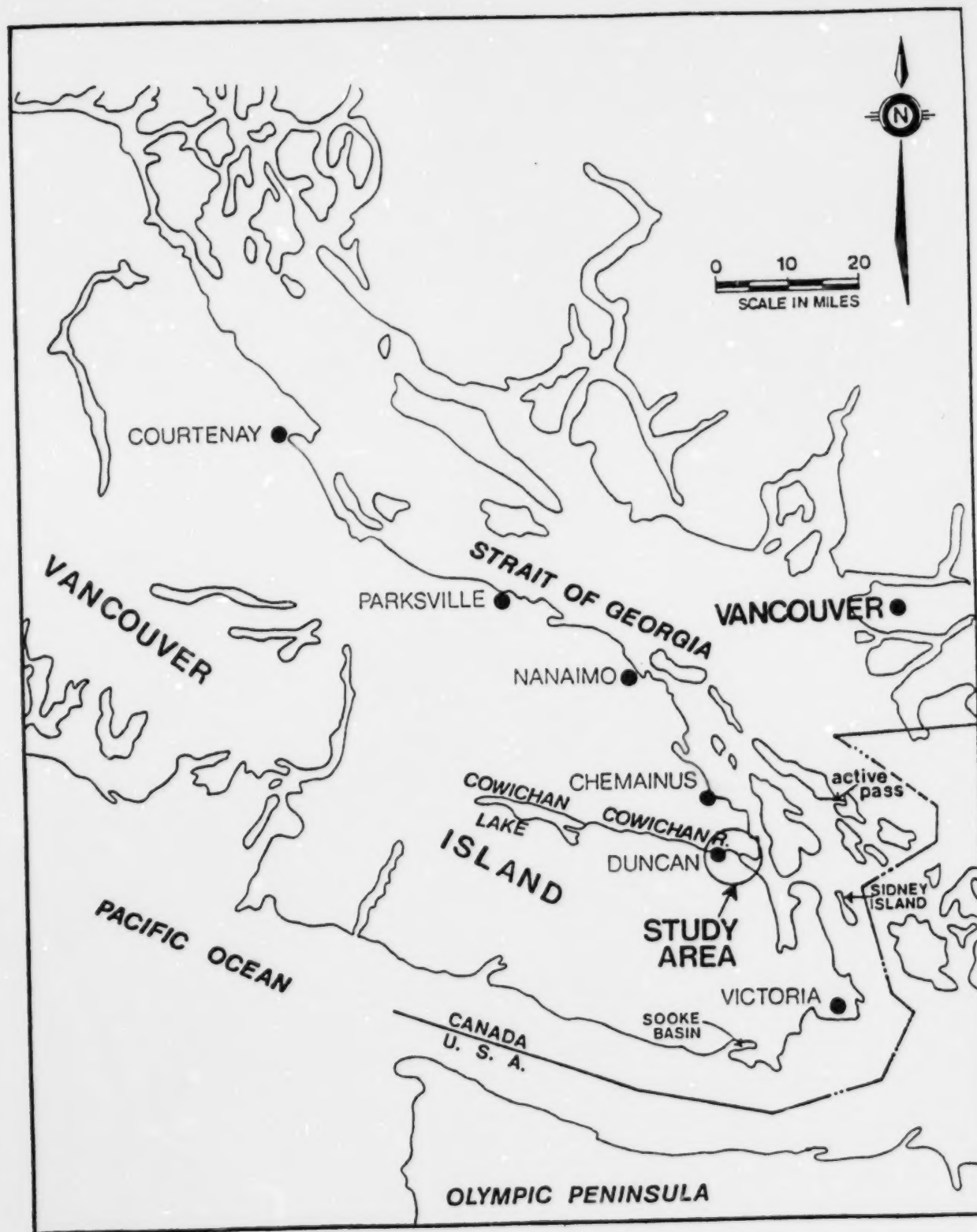
The objective of the Wetlands Are Not Wastelands program is to test alternative methods of wetland evaluation in different wetland locations in Canada. Three methods: willingness-to-pay, opportunity cost and cumulative impact assessment are applied to potential development scenarios in the Cowichan wetlands on Vancouver Island, for the purposes of testing the methods. The focus of the study is to develop practical and credible methods for evaluating the effects of development on the functions and values derived from wetlands.

The location and boundaries of the study area are shown on Figure 1 and Figure 2. The area incorporates the intertidal and immediate backshore zones and the subtidal edge of the Cowichan River and Koksilah River estuary.

The *Cowichan wetlands* are defined as the backshore and intertidal lands which are subject to fresh and/or salt water inundation on a daily (tidal) or seasonal (freshet) basis, and the associated river channels and shallow, brackish waters in the Cowichan and Koksilah River estuary. They encompass a spectrum of marine and freshwater habitats.

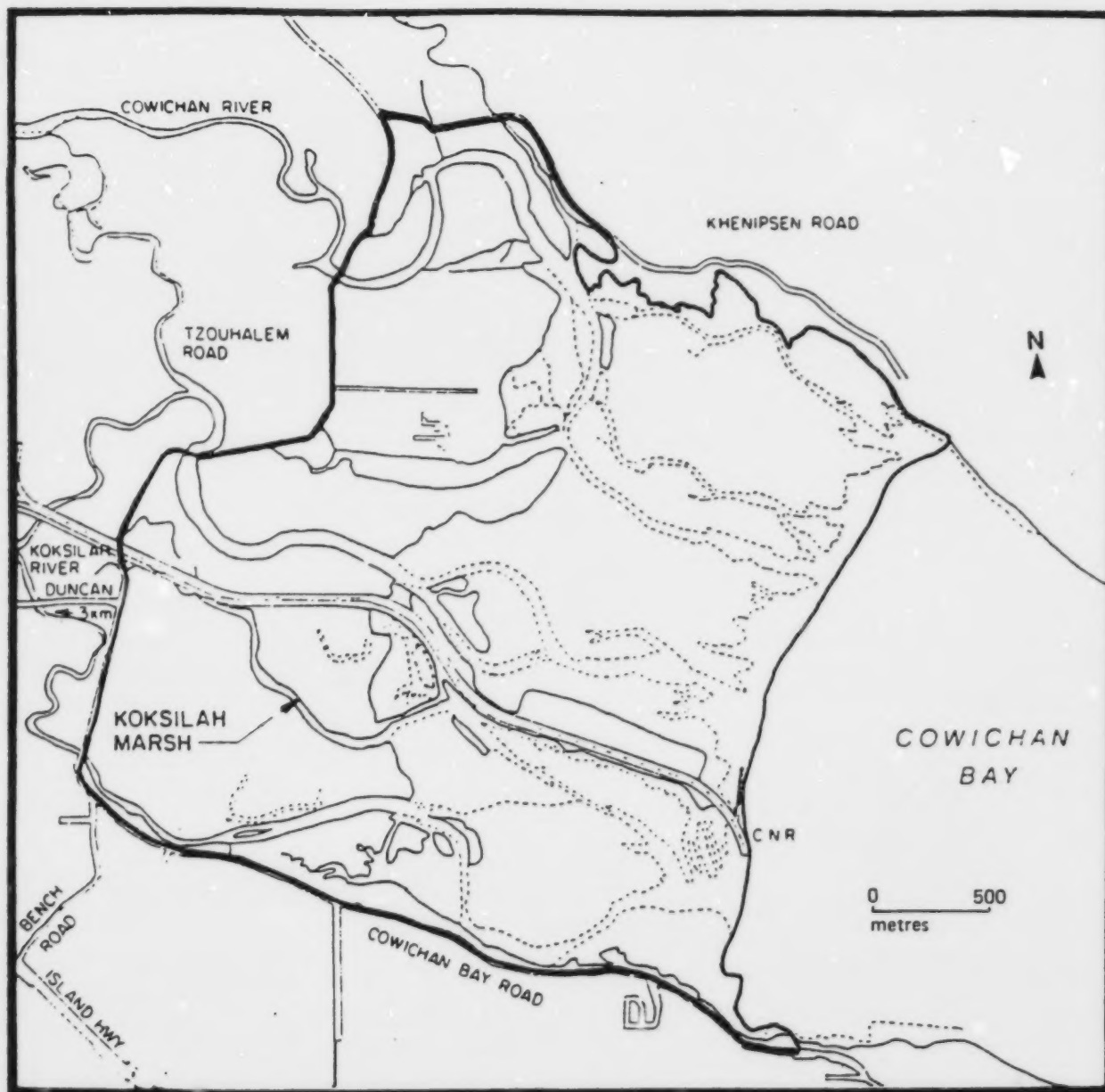
Wetland functions are defined as the interrelated physical and biological processes within wetlands which generate identifiable benefits to society. Wetland attributes are defined as the physical and biological features or components which collectively contribute to the wetland functions.

Wetland products are defined as the measurable goods and services provided to society from wetlands. They include the full range of public and private benefits associated with fisheries, wildlife, recreation, education, scientific research, flood protection, water quality renovation etc., and the complex option and existence values provided by wetlands.



LOCATION OF THE COWICHAN RIVER
STUDY AREA IN SOUTHWESTERN
BRITISH COLUMBIA

FIGURE 1



STUDY AREA

FIGURE 2

2.0 STUDY APPROACH

The study approach focussed on identifying the attributes of the wetlands and producing measures of wetland function and value associated with such attributes. The central problem, as described in the background paper (Manning et al., 1988), is to formulate "some direct or indirect measures of deriving appropriate indicators of value that may be ascribed to specific areas" of wetland.

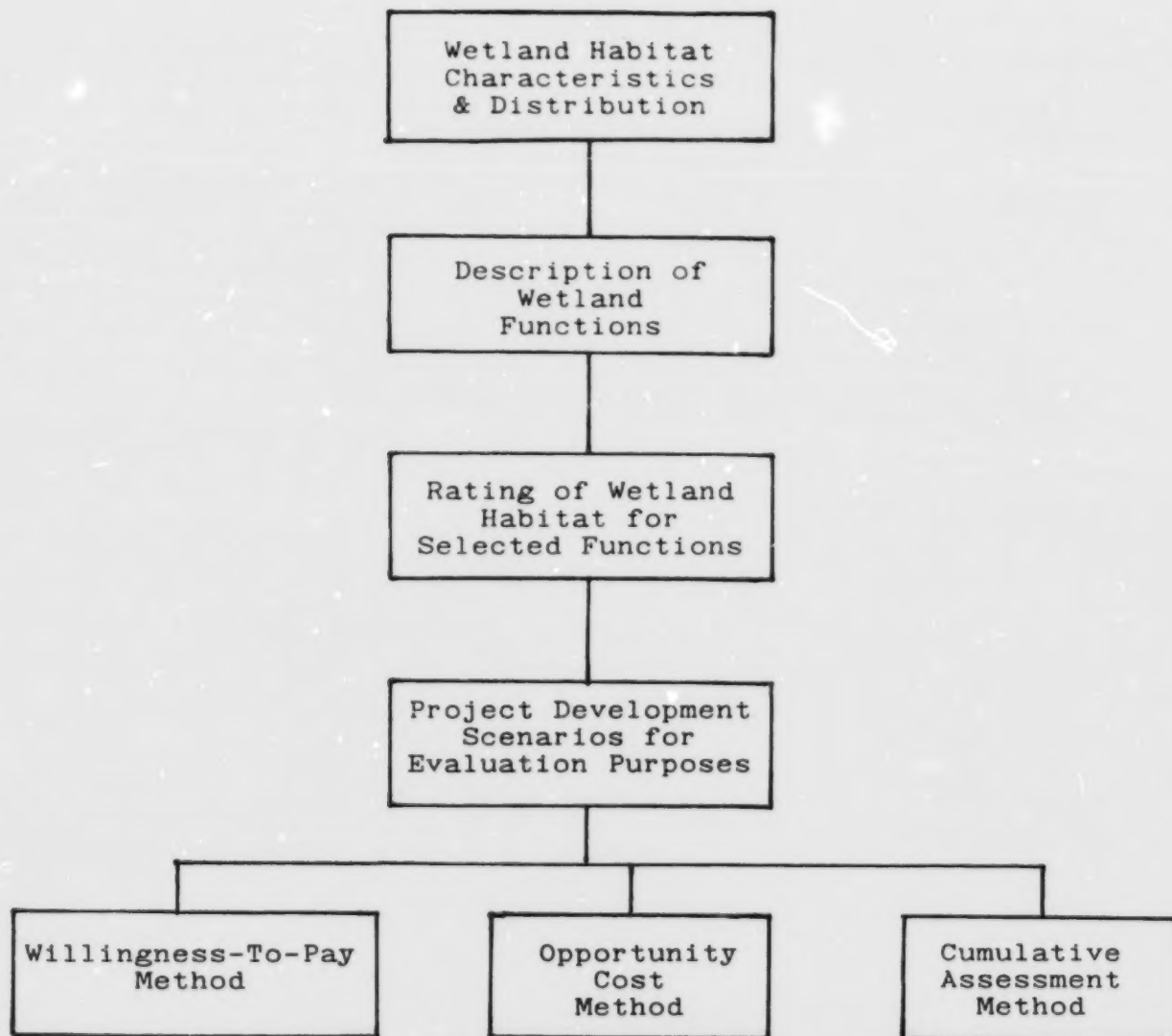
Figure 3 outlines the study approach. The emphasis was placed on providing a range of indicators of wetland significance. Phase 1 focussed on the classification and rating of wetland habitat for selected products and the review of overall wetland functions. Phase 2 involved the application of the methods. The study methods are described in detail below.

2.1 Wetland Evaluation Methods

The selection of a wetland evaluation method depends upon the purposes of the evaluation and the available resources for evaluation. A wetland evaluation method which assesses the functions performed by the wetland attributes should ideally consider the ecosystem relationships within the wetland and between the wetland and the watershed. A *modelling approach* involves the development of estimates of the functional relationships between ecosystem components. The data requirements in defining the system model, however, usually limit the feasibility and practicality of this approach.

Given the scientific uncertainties and data deficiencies, many wetland evaluation methods have adopted a rating approach to the analysis of functions. Adamus et al. (1984) describe a method by which the wetland is rated in terms of its value (high, moderate, low) for each function (threshold analysis), then compared to other wetlands in terms of its functional values (comparative analysis), and finally, assessed in terms of the cost effectiveness of mitigation alternatives. The initial step involves identifying the "opportunity" of the wetland to perform the function, the "effectiveness" or probability of maximizing the opportunity, and the "significance" or values of the functions performed.

FIGURE 3: WETLAND EVALUATION FRAMEWORK



Rating methods have also provided a means of implementing mitigation policies such as the Department of Fisheries and Oceans (DFO) "no net loss" policy for fish habitat, and the U.S. Fish and Wildlife Service "Mitigation Policy". For example, the U.S. Fish and Wildlife Service utilize a Habitat Evaluation Procedure which rates the suitability of different habitats for selected species, and then evaluates these habitat units in terms of management criteria or "relative value indices" (U.S. Fish and Wildlife Service, 1980). Although the procedure depends upon considerable information about species habitat suitability, it provides a means of making trade-offs between habitats.

Many studies have used a more fundamental rating system. The Squamish Estuary Study (Government of Canada/Province of B.C., 1981) for example, used "habitat priorities" - critical, important, moderate, limited, to assess wetland habitats. Slightly more elaborate methods were used in the Columbia River, Fraser River and Nanaimo River estuaries, where generalized ratings of the productivity and species diversity by habitat types were used to define a framework for impact assessment and mitigation (State of Oregon, 1984; Williams & Assoc., 1987; Government of Canada/Province of B.C., 1980).

Habitat rating methods can also be used (cautiously) to estimate the marginal effects of wetland development on total wetland functions and values. Prediction of cause and effect relationships (e.g. between fish habitat degradation and species decline) and the coefficients of these relationships are generally built upon professional judgements of probability about the proportionate loss of a wetland function (e.g. Meyer and Dolphin, 1978). Impact assessments are therefore normally imprecise. However, if one accepts the risk management perspective of a "safe minimum standard", gross estimates of potential loss of wetland function and value generally provide a worst-case scenario of the impacts of development.

Such estimates provide a frame of reference for evaluating the benefits of wetland development or preservation. Gupta and Foster (1975) for example, estimated the values associated with high, medium and low levels of wetland productivity in Michigan, against which to compare the social costs of preservation. More recent studies have adopted a planning approach which assesses wetland development options in relation to cost effectiveness, ecological sustainability and amenity conservation goals (Turner & Brooke, 1988).

The policy and decision making context is an important consideration to the selection and application of wetland evaluation methods. The greater the scientific uncertainties in predicting impacts, the less that decision processes should depend upon one evaluation method or set of environmental accounts.

But the uncertainties in wetland evaluation are not confined to the biophysical or habitat-function relationships. There remains considerable debate about the use of various economic methods (willingness-to-pay, market transactions, opportunity cost, replacement cost) in wetland valuation. In order to minimize the dependence upon one method, the process of evaluation should attempt to display a range of physical, biological and socio-economic information on the implications of wetland preservation or development.

2.2 Cowichan Study Design

The research components are outlined on Figure 3. A habitat-based approach is used in order to identify the variations in wetland attributes and functions within different parts of the Cowichan wetlands study area. The research essentially involved eight steps:

- (1) identifying the habitat characteristics and their distribution in the Cowichan wetland study area;
- (2) describing selected wetland functions, including estimates of the use and capability of the wetlands to generate various socially-valued products;
- (3) evaluating the significance of the various wetland habitat types in terms of their relative ability to support and maintain the selected wetland functions.
- (4) identifying two potential development scenarios in the Cowichan wetlands, for the purposes of testing the wetland evaluation methods;
- (5) evaluating the economic benefits derived from the Cowichan wetlands using a willingness-to-pay survey and assessing the potential economic losses associated with development;

- (6) evaluating the economic benefits foregone from wetland preservation using an opportunity cost approach to assessing the potential economic costs associated with preservation;
- (7) evaluating the cumulative impacts of additional development in the Cowichan wetlands based on a series of indicators of the wetland functions and values;
- (8) evaluating the results of the three methods and their applicability to other wetland development situations.

The initial step was to prepare a wetland habitat map, identifying eight categories of habitat types. Four "products" of the wetlands were then selected for detailed evaluation: fish, birds, recreation and water quality. The major characteristics of these functions were reviewed based upon available information, particularly the Cowichan Estuary Task Force Report and appendices (ELUCS,1980). Various measures of the total production capability of the wetlands for the selected functions were derived from available data and discussions with government agencies.

Once a description of the existing and potential functions of the overall wetland was prepared, the next step was to assess the distribution of these functions by habitat types. The evaluation of the wetland habitats involved the use of a rating system which assessed each habitat on a scale of 1-5 (1=low; 3=moderate; 5=high) for its relative ability to generate the selected functions and for its relative abundance. Habitat types were therefore, weighted according to a capability rating and a scarcity rating.

The habitat evaluation data serves as a basis for analyzing physical changes in habitat and, if the analyst so chooses, for proportioning total wetland products and values according to habitat types. While there are definite limitations in proportioning the products and values of wetlands according to habitat distribution, this evaluation method provides one type of readily accessible data for the application of impact assessment and valuation methods within a multiple accounts framework.

2.3 Limitations and Advantages of Habitat Rating

The Cowichan Study uses a habitat rating method to assess wetland functions. The limitations of this approach are primarily threefold:

- (a) the assumed linear relationship between habitat rating and the production of wetland functions and products is a highly simplistic view of complex and integrated wetland relationships.; and
- (b) wetland functions and products cannot be easily disaggregated and apportioned into discrete spatial units since they are dependent on the overall maintenance of the wetland system; and
- (c) the capability of wetlands to produce specific functions may be higher than the existing levels of production of these functions and estimates of potential production can be somewhat speculative, depending upon available scientific data and future enhancement activities.

Wetlands operate as dynamic ecosystems within larger watershed processes. It is difficult to isolate the functions of the wetlands from the watershed or to separate the functions of specific areas or sites within the wetlands from their larger context. The spatial and functional interconnections are neglected in a compartmentalized approach since the whole of the wetland is greater than the sum of it's habitat units. Many of the unquantifiable benefits of the wetlands are also overlooked in this approach. Thus, attempts to proportion the overall wetland functions to specific habitat units are invariably simplified interpretations of complex wetland ecosystems. Aggregating the ratings of such units can also mask important variables (Smith and Theberge,1987).

Determining the potential of wetlands to generate specific functions over and above existing levels is also fraught with problems. Capability can be dependent upon the level of management investment to protect and enhance the resource function within the wetlands and beyond. Some functions such as anadromous salmon and migratory birds are dependent on conditions elsewhere as well as within the wetlands. And there are additional difficulties in attributing all of their values to a wetland when only a portion of their life cycle occurs within the wetland.

While there are inherent biases and the potential for misuse of these types of rating methods, they do offer some distinct advantages. First, they provide a simple, quantitative measure for defining baseline conditions and assessing impacts on wetland habitat which reflect the relative importance of different physical units for various wetland functions. Second, they provide a basis for project benefit-cost analysis and impact mitigation and compensation, including the implementation of a no net loss and habitat replacement policy. This approach provides an order of magnitude estimate of the potential resource losses from a project and the scope of habitat replacement which may be necessary to offset such losses. Third, because they focus on physical habitat and ordinal rating, they do not require comprehensive data and can be quickly and easily administered. In spite of the scientific limitations, the method provides a useful framework for assessing development impacts and for making trade-offs between habitat types.

PHASE 1

3.0 FUNCTIONS OF COASTAL WETLANDS

Vegetated marine intertidal habitats such as coastal wetlands and eelgrass beds function in a number of different ways to modify the coastal marine environment and to interact with marine species. These wetland functions can be of considerable economic, social, and esthetic value to humans.

Coastal wetland functions and values are a result of the structure of the wetland and the processes occurring within it. The processes are essentially similar for most coastal wetlands. Differences between coastal wetlands are primarily attributable to different structural features such as the watershed characteristics, the size of the wetland, its plant species composition and plant productivity.

Estuarine wetlands such as the Cowichan, are especially unique because of their higher plant species diversity and production compared to non-estuarine coastal wetlands. Estuarine wetlands also serve as critical habitat for rearing or resting and feeding juvenile salmon and waterfowl.

Coastal wetland functions can be described according to their perceived human values. Particular emphasis will be on the role of estuarine wetlands (including eelgrass beds) in the coastal marine environment. Wetland functions are briefly discussed below in terms of physical, chemical, and biological processes.

3.1 Physical Function: Substrate Stabilization

Tidal marsh plants have a large and robust root and rhizome structure. The extensive and solid root mat developed in a marsh community has a considerable stabilizing effect on the substrate. As such, the U.S. Army Engineer Waterways Experiment Station has numerous published examples (Herner & Co. 1980) of the use of tidal marsh plants for stabilizing marine substrates (Allen et al. 1984).

Studies have shown that eelgrass beds can tolerate current velocities up to 120-150 cm/sec (Fonseca et al. 1983). This natural anchoring ability of eelgrass plants contributes to the overall stability of soft marine substrates in estuaries such as the Cowichan.

3.2 Chemical Functions: Assimilation and Treatment of Pollutants

Marsh plants have a large capacity for assimilating nutrients, especially nitrogen and phosphorus. Treatment processes that are designed into sewage treatment plants (e.g. microbial activity, organic matter degradation and denitrification) are sustained at high natural rates in the wetland environment. Thus, natural as well as constructed wetland are now being used quite successfully to treat municipal sewage and industrial wastewater (Reddy and Smith 1987).

Estuarine marshes therefore have a natural self-cleansing effect on estuarine water quality. Heckman (1985) described the role of littoral vegetation in the purification of nutrients and toxic contaminants in the Elbe estuary in Germany.

3.3 Biological Functions

3.3.1 Rearing and Feeding Habitat for Juvenile Salmon

Estuarine wetlands in coastal B.C. are a critical and important environment for the rearing and feeding of juvenile salmon. Studies in the Nanaimo River estuary (Sibert et al. 1977) and the Fraser River estuary (Valiela and Kistritz 1979, Levy and Northcote 1981) have shown that juvenile chum and chinook salmon rear for several weeks in marsh habitats. This estuarine residence period is an important aspect of the life cycle of Pacific salmon species such as chum and chinook. A food web diagram for juvenile salmon in a typical estuarine marsh environment is shown in Figure 4.

3.3.2 Rearing Habitat for Other Marine Fishery Species

Eelgrass beds are often associated with coastal wetlands and estuaries because they require similar protected conditions and soft substrate. Because eelgrass grows in lower intertidal to shallow subtidal marine and estuarine habitats, it provides an important habitat to a variety of marine fishery species (Thayer and Phillips 1977). Eelgrass habitat is especially important to commercially important fishery species such as the Dungeness crab, Pacific herring, and various flatfish species. A food-web diagram of a typical eelgrass habitat of the Pacific Northwest is shown in Figure 5.

3.3.3 Habitat for Migrating and Resident Birds

Estuarine wetlands in B.C. provide critical wintering habitat for migrating waterfowl populations. Some bird species such as snow geese and black

Food Webs

Figure shows the food web of a typical slough or tidal channel marsh habitat in the Fraser River estuary (from Kistritz 1978).

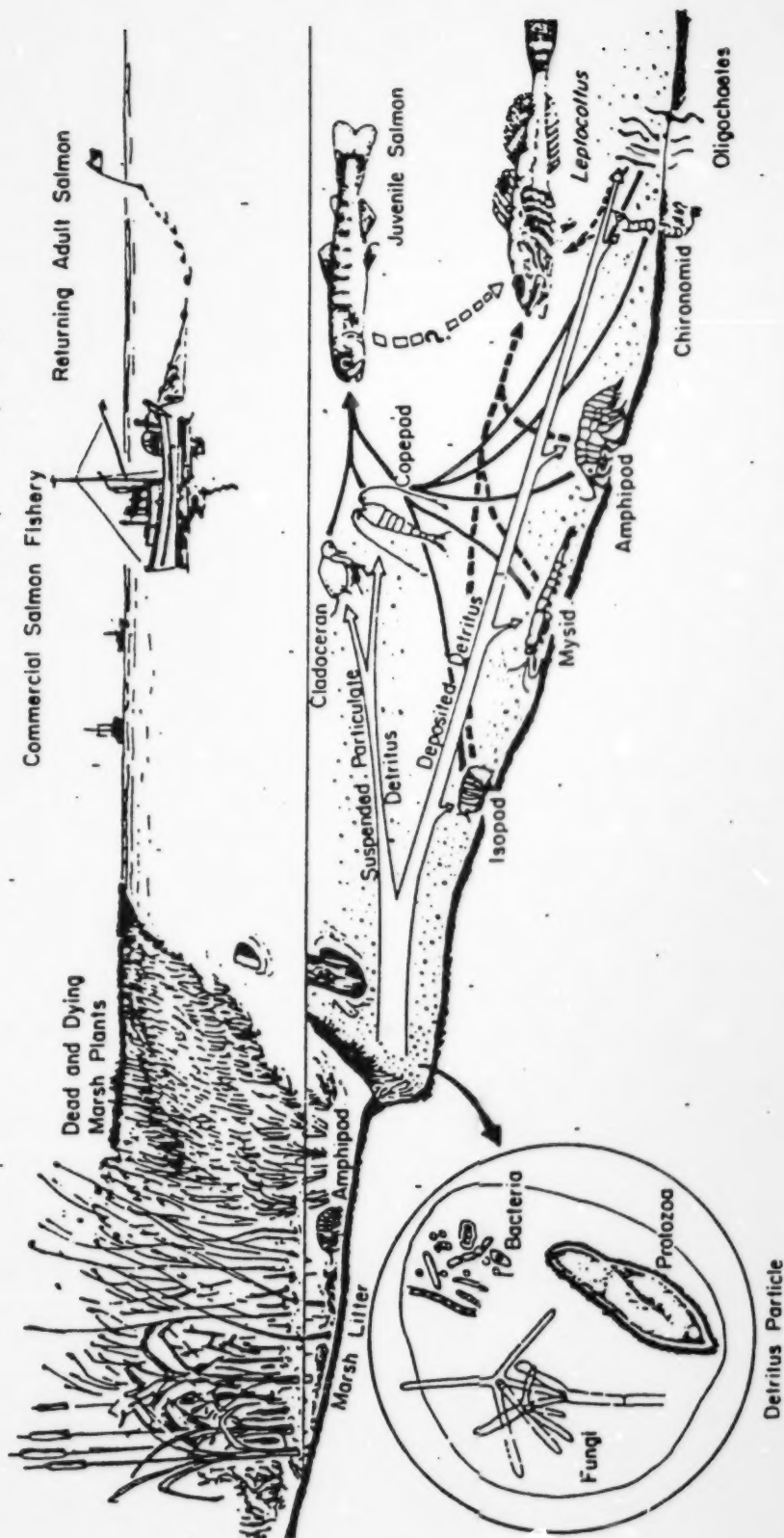


FIGURE 4

Food Webs

Figure shows some typical organisms associated with eelgrass blades, plant bases and roots, and the general environment of the eelgrass bed in the Pacific Northwest (from Thayer and Phillips 1977).

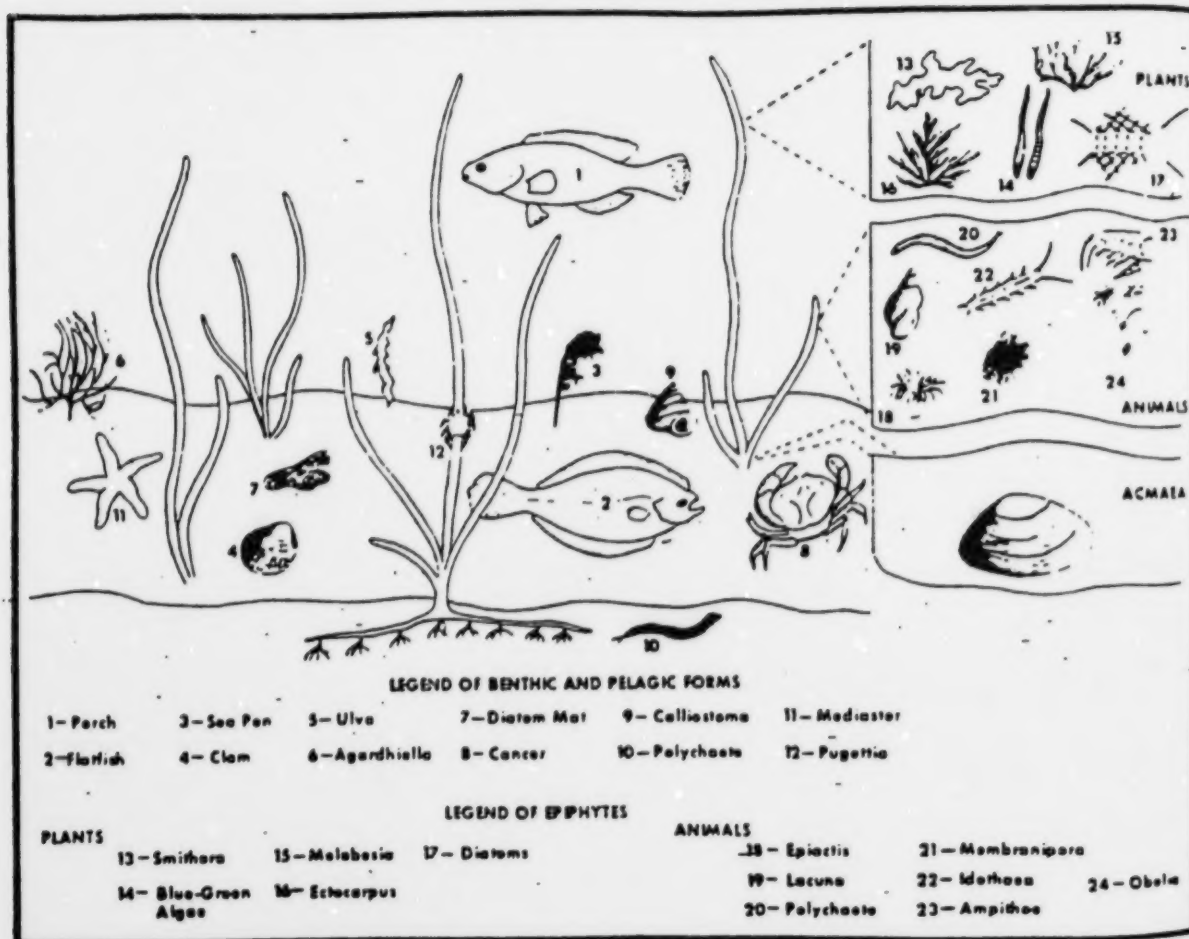


FIGURE 5

brant are associated with particular types of habitat because of their specialized feeding habits. Most other bird species are dependent on the overall high wetland productivity. The interface of freshwater and marine habitats provides for a variety of dabbling ducks, diving ducks, raptors and shorebirds. Emergent marsh vegetation is also used for nesting habitat by species such as Marsh Wrens and Red-winged Blackbirds, although fluctuating water levels can also limit nesting in the intertidal areas.

3.4 Socio-economic Functions

Estuaries, through their biophysical functions, support major commercial, sport and Native fisheries in B.C. Degradation of wetland habitat has a direct effect on the capability of the system to sustain harvesting levels. Crab and herring fisheries are also often dependent upon estuarine areas for rearing and spawning habitat.

Recreation values associated with wetlands include wildlife viewing, sport fishing, hunting and boating activities. There are also option and existence values related to the maintenance of such wetlands.

Ecological values include the benefits to society of maintaining representative areas of flora and fauna, preserving irreplaceable gene pools and providing for scientific research and education.

4.0 THE COWICHAN ESTUARY WETLANDS

4.1 The Study Area

The Cowichan estuary wetlands consist of 488 hectares of intertidal and backshore areas at the outlet of the Cowichan River and Koksilah River. The Cowichan River originates in Cowichan Lake, approximately 47 km west of the estuary, draining the mountainous slopes of the Vancouver Island Range. The Koksilah River originates from the slopes of Waterloo Mountain located to the south of the Cowichan Valley. Together, the two rivers provide most of the fresh water inflow to Cowichan Bay and the estuary.

The study area, shown in Figure 2, is contained within the boundaries of the Cowichan Estuary Environmental Management Plan (Ministry of Environment, 1984). About 70 percent of the Cowichan wetlands are under tidal influence and 30 percent are dyked or otherwise above tidal influence. Between 1947-1980, approximately 7 percent of the natural estuarine area was displaced by landfilling, in addition to extensive agricultural dyking.

The wetlands are used for a variety of agricultural, industrial, recreational and habitat management activities. The overall pattern of wetland and upland use is shown in Figure 6. The major portion of the estuary is included within Lot 160 which is owned by Canadian National Railway, originally acquired in 1925 from the Province of B.C.

The industrial sites within the area include the Doman sawmill site and the Westcan Terminal port facilities. Almost one-half of the intertidal area has been leased for log storage purposes in the past, but this has now been reduced to about one-fifth of the area. Log storage rights have been a major concern for four forest companies having leases in the estuary. Through the implementation program of the management plan, a formal set of contractual agreements has been produced between industry and the Federal and Provincial governments, significantly minimizing the use of the intertidal areas for log storage and sorting. This has been assisted by the industry trend toward dry-land sorting and better capabilities for deep water log storage. The designations within the management plan are also reinforced in the Official Community Plan for the area (Cowichan Valley Regional District, 1975).

The port facilities, owned by CNR and operated by Westcan Terminals, serves an important role for the forest industry on Vancouver Island. The management plan specifies that expansion of the port may occur sometime in the future within a 70 hectare site adjacent to the existing terminal. In exchange for reserving the option for port expansion, subject to meeting appropriate environmental requirements, the company has agreed to conservation designation of the undeveloped portions of Lot 160.

Large tracts of former floodplain and intertidal zone within the Cowichan wetlands have been dyked, drained and cultivated. The predominant agricultural activity is

Generalized Existing Uses

COWICHAN ESTUARY PLAN IMPLEMENTATION PROGRAM

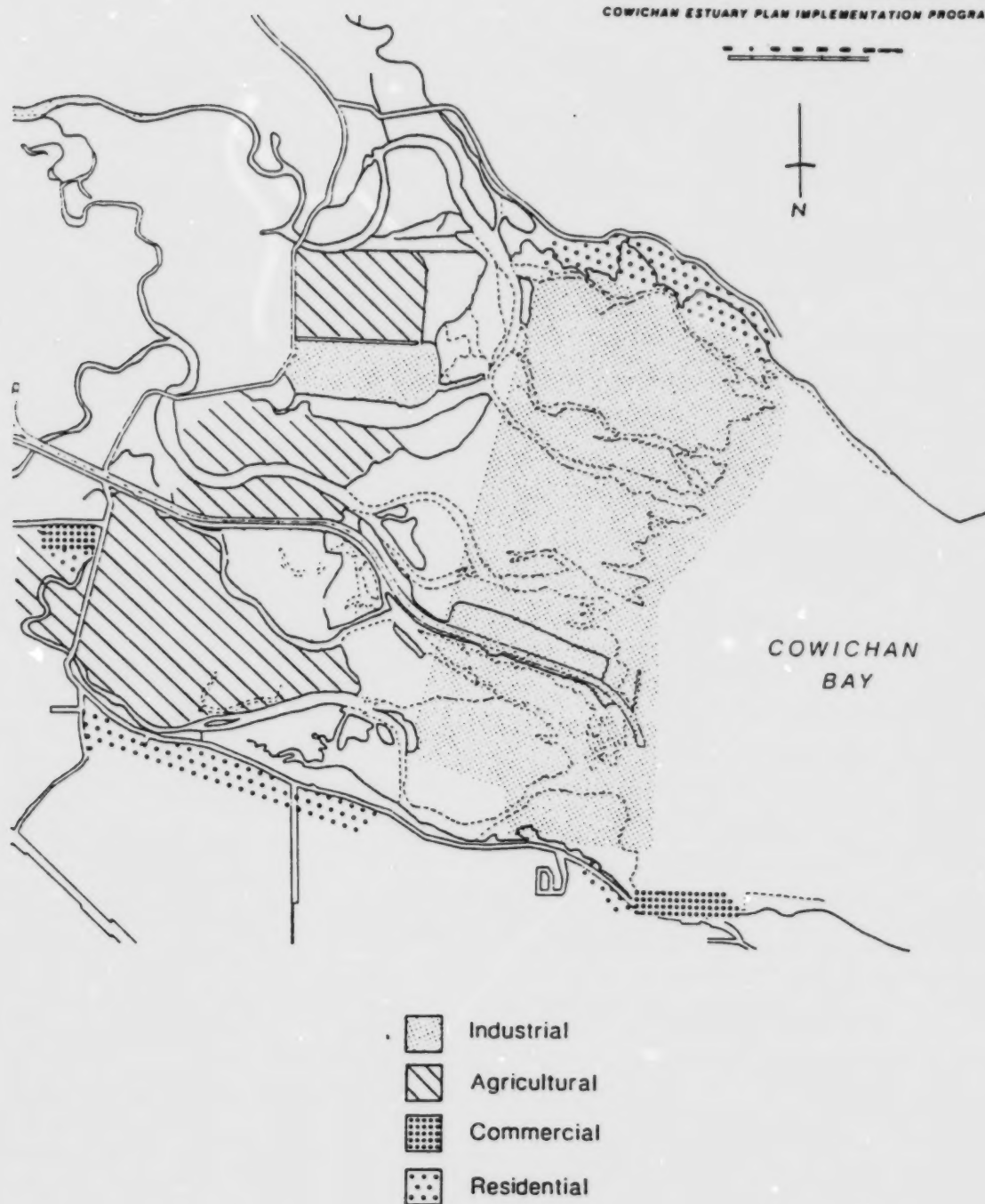


FIGURE 6

forage and beef and dairy cattle production. The Blackley farm, owned by Doman Industries, is located immediately north of the sawmill. The Dinsdale farm is located near the causeway to Westcan Terminals (Figure 6).

Although the area has good capability for agriculture, farming activity has declined in recent years. Adequate drainage and flood protection have been significant factors affecting the viability of agriculture in the wetlands. Both of the farms have been affected by breaches of the seaward dykes during winter storms, resulting in salt water inundation. Portions of each of the farms which have been subject to saltwater intrusion have been donated or sold for habitat conservation purposes.

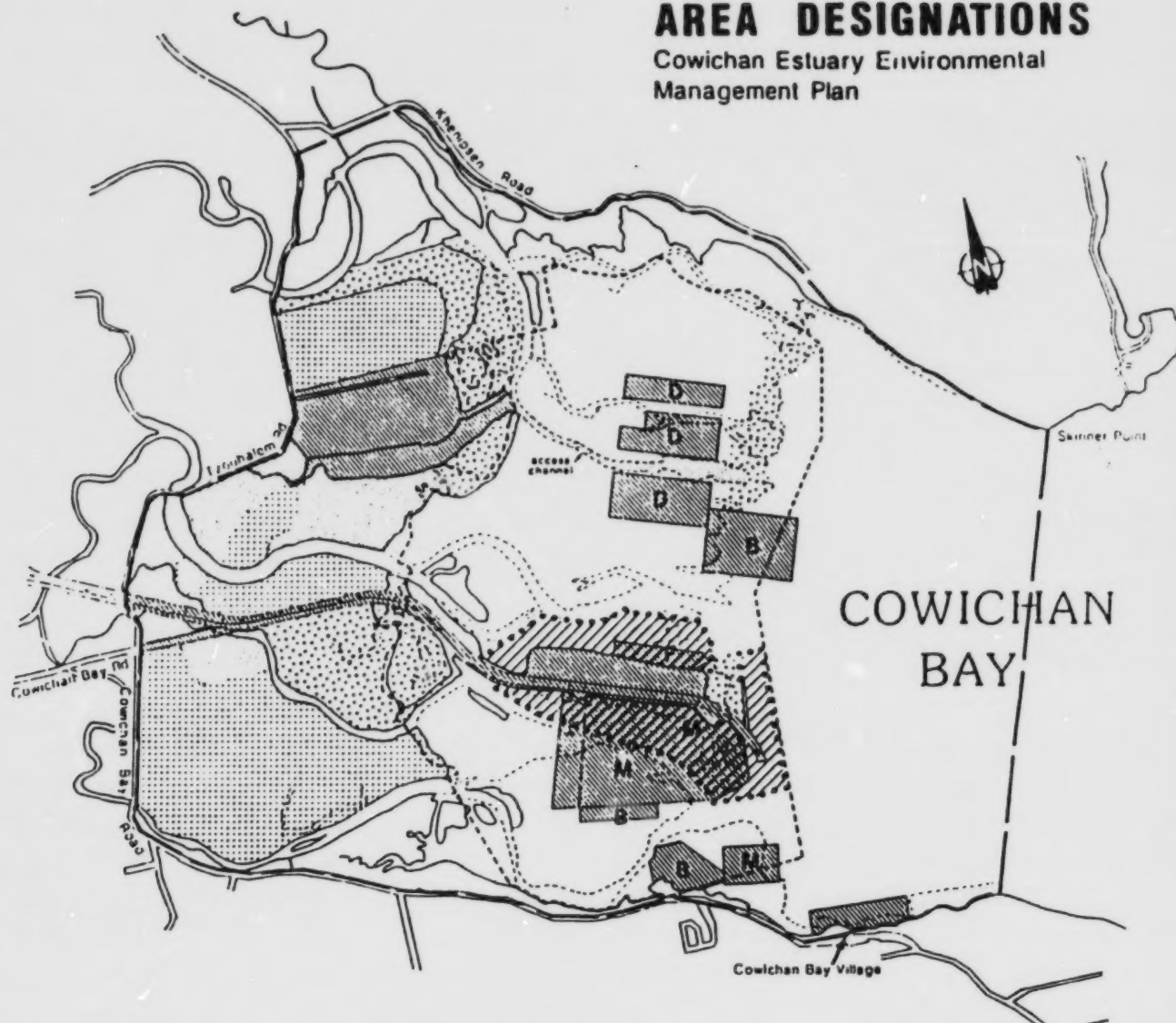
During the last fifteen years, the Cowichan estuary has been the center of major land use conflicts over industrial development and wetland preservation. The first Cowichan Estuary Task Force (1974) produced a report which recommended no further expansion of industrial development. However, further pressure to expand development led to a second task force review. The Cowichan Estuary Task Force Report (ELUCS, 1980) provided a detailed assessment of issues and alternatives which eventually led to the preparation of an environmental management plan (Ministry of Environment, 1984). The area designations shown on Figure 7, which were determined through a process of negotiation between the major interests in the Cowichan, have been established to guide future uses of the wetlands.

Recent initiatives have been undertaken to restore and enhance areas of fish and wildlife habitat in the estuary. Some 9.3 hectare of land on the seaward side of the Blackley farm have been dedicated to the Crown by Doman. A new dyke was constructed to protect the remaining farmland and the dedicated area has undergone controlled inundation by both fresh and saline water in order to promote salt marsh habitat for waterfowl and aquatic communities.

A similar enhancement project has occurred in an area south of the Westcan Terminal causeway, involving about 25 hectares of land. This area, comprised of the "CN marsh" and a portion of the Dinsdale farm, was once used for agriculture. In 1982, a major storm breached the gravel berm dyke protecting the farmland and resulted in salt water damage to crops. The owner was unable to restore the dyke

AREA DESIGNATIONS

Cowichan Estuary Environmental
Management Plan



LEGEND

Industrial / Commercial	
Agriculture	
Habitat Management	
Possible Mixed Use	
Conservation / Recreation	
Log Storage	
Doman D	
MacBlo M	
BCFP B	
Fall F	
Potential Port Expansion	
Plan Boundary	
Lot 160 Boundary	

FIGURE 7

and the property was eventually sold to the Nature Trust of B.C. for conservation purposes. The land is now being allowed to reconvert to salt marsh habitat.

Other enhancement possibilities include the future expansion of eel grass areas on the outer intertidal area, and greater control of sewage and agricultural discharges to improve water quality for shellfish and other aquatic life.

4.2 Wetland Classification

The classification of wetland into geographic units assists in distinguishing between groups of wetland attributes. For the purposes of this study, a generalized set of wetland categories common to coastal estuaries was used to identify the overall pattern of attributes in the Cowichan estuary. This broad distribution of wetland habitat types provides the basis for assessing related functions of the wetlands.

In B.C., an estuarine habitat classification system has been developed to provide a consistent basis for evaluation (Hunter et al., 1983). About 25 percent of the Cowichan wetlands has been mapped at 1:2500 scale using this classification system (Ministry of Environment, 1982). In addition, vegetation mapping of all of the estuary was undertaken in 1975-78 at 1:10,000 scale (Ministry of Environment, 1980). On the basis of these two data sources, and updating the maps with recent colour air photos, wetland characteristics were grouped into eight categories.

Table 1 displays the major wetland types within the Cowichan. Using colour air photographs and a site visit, along with discussions with Provincial staff regarding recent habitat changes, each of the categories was mapped on 1:5000 scale ortho-photo mosaic maps of the area. This mapping was cross referenced with relevant portions of the available estuarine and vegetation mapping to enhance the accuracy of the final wetland habitat map. The availability of an ortho-photo base with elevation levels greatly assisted in the preparation of this classification map.

Figure 8 presents a summary map of the habitat types. The wetland types and land uses (excluding foreshore log booming leases) occurring within the Cowichan study area are as follows:

TABLE 1: WETLAND CLASSIFICATION

Riparian - cottonwood, willow and other riparian vegetation along the main channels of Cowichan and Koksilah Rivers

Marsh and Pond - former intertidal lands with organic substrates and grass areas on silty sand substrates, subject to seasonal flooding; and temporary and permanent pond habitat.

River Channel - major channels of the Cowichan and Koksilah Rivers and major channels draining backshore and intertidal marshes predominantly above 0.2m elevation.

High Intertidal Marsh - upper intertidal areas dominated by Douglas aster, Arctic rush, creeping bent grass, tufted hair grass, Pacific silverweed, sea milkwort, Baltic rush, couch grass- Canada thistle, and Lyngbyes sedge generally found between 2.8 - 3.3m (above mean higher high water level).

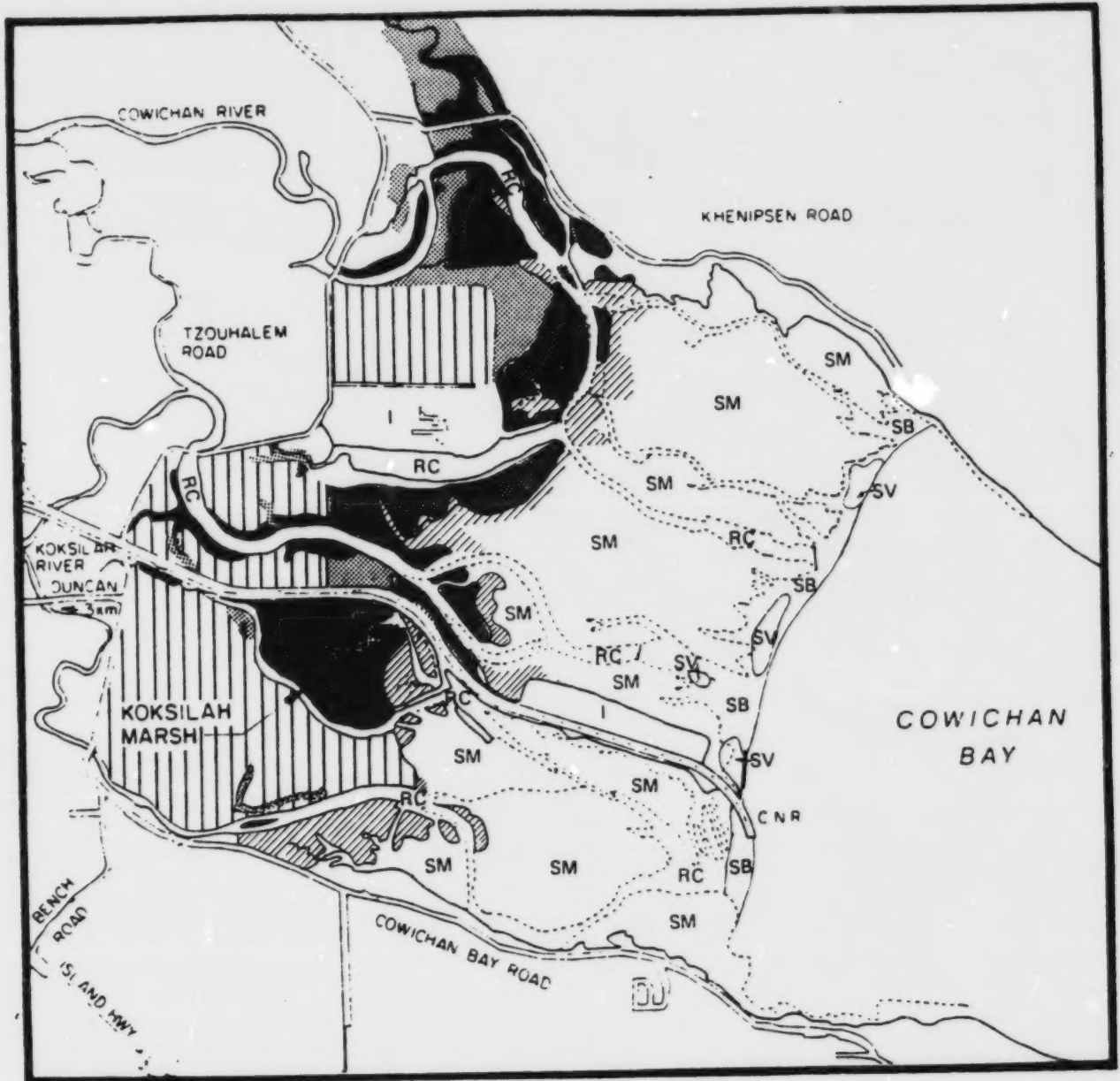
Low Intertidal Marsh - lower intertidal areas dominated by Lyngbyes sedge, sedge-couch grass, arrow grass, tufted hair grass, and pointed rush, generally found between 2.3 - 2.8m (below mean higher high water level).

Mud and Sand - low gradient intertidal sand and silt substrates colonized by filamentous green and red/brown algae and occasional low marsh plant species.

Submergent Vegetation - identifiable submergent plant communities dominated by eel grasses.

Brackish Shallow Water - shallow subtidal areas draining the mud and sand habitat located generally below 0.2m elevation.

SOURCE: based on the Distribution of Vegetation map in the Cowichan Estuary Task Force Report; Environment & Land Use Secretariat, 1980; Cowichan Estuarine Habitat Inventory Map, Ministry of Environment, 1982; and a site visit.



SM	SAND/MUD	I	INDUSTRIAL
	LOW MARSH	SB	SHALLOW, BRACKISH WATER
	HIGH MARSH	RC	RIVER CHANNEL
	BACK SHORE MARSH and POND	SV	SUBMERGENT VEGETATION
	RIPARIAN		
	AGRICULTURE		

HABITAT AND LAND USE CLASSIFICATION

FIGURE 8

	<u>Study Area</u>	<u>Wetland Habitat</u>
Agriculture	100 ha (20.5%)	-
Industry	29 ha (5.9%)	-
Riparian	10 ha (2%)	2.8%
River Channel	42 ha (8.6%)	11.7%
Marsh and Pond	18 ha (3.7%)	5.0%
High Intertidal Marsh	54 ha (11.1%)	15.0%
Low Intertidal Marsh	32 ha (6.6%)	8.9%
Sand and Mud	173 ha (35.5%)	48.2%
Submergent Vegetation	5 ha (1%)	1.4%
Brackish Shallow Water	<u>25 ha (5.1%)</u>	<u>7.0%</u>
Total	488 ha	359 ha

5.0 DESCRIPTION OF WETLAND FUNCTIONS

5.1 Fish

The Cowichan River is recognized as one of the most important salmon producing rivers on Vancouver Island (Bell and Kallman 1976). The fishery productivity of the Cowichan system is attributable to the overall abundance and accessibility of spawning and rearing habitat. The Cowichan system supports large runs of chinook, coho, and chum salmon. The chum stock is among the largest native to Vancouver Island streams (Anderson 1974). There is also a winter and spring run of steelhead in the Cowichan. Juvenile chum and chinook salmon and possibly juvenile steelhead rear in the estuary for a time before leaving the river system. Other resident or migrating fish species known to use the estuarine habitat of the Cowichan are cutthroat trout, flatfish, long-finned smelt, and herring.

The dependence of juvenile salmon (chum, chinook, and coho) on all levels of the Cowichan/Koksilah estuarine food webs is described in the Cowichan Estuary Task Force Report, Appendix 8 (1980). Nearshore and estuarine invertebrates were shown to play an important role in the diets of juvenile salmon during their out migration period (ibid.). Utilization of the estuary by cutthroat trout appears to be related to physical factors such as tides and river

flow (op. cit.; Appendix 10). Levy and Northcote (1981) observed that for juvenile chum and chinook salmon utilizing the Fraser River estuary, the amount and physical availability of estuarine wetland habitat was positively correlated to salmon fry densities.

Tidal channels, sloughs, and backwater areas that are easily and frequently accessible by juvenile salmon are considered to be the most important habitats in estuaries based on juvenile salmon studies done to date. Low marsh areas surrounding these rearing habitats support the food web that the juvenile salmon depend on.

Salmon and steelhead escapement statistics provide an indication of valued fish species which utilize the Cowichan estuary. The average annual escapement is:

<u>Species</u>	<u>Cowichan</u>	<u>Koksilah</u>	<u>Total</u>
Chinook	6,100	470	6,570
Coho	37,470	6,150	43,620
Chum	71,050	4,400	75,450
Steelhead	3,100	1,300	4,400
Searun Cutthroat	1,900	1,800	3,700

5.2 Wildlife

A wide range of small mammals and birds use the Cowichan wetlands. Aquatic furbearers, including muskrat, mink and river otter are common in the estuary. The most abundant mammal is the Townsend vole, an important food species for birds of prey. Marine mammals such as harbour seals, sea lions and Killer whales occasionally occur in the vicinity of the estuary. Blacktail deer are also occasionally sighted in the area.

The major wildlife role of the Cowichan wetlands is in providing habitat and particularly important wintering habitat for waterfowl and raptors. Appendix 10 of the Cowichan Estuary Task Force Report describes the waterfowl populations:

The Cowichan estuary is an important part of the Georgia Strait's waterfowl habitat, which is the major migration and staging area along the Pacific Flyway. Birds from the west coast of the continental U.S.A., as

well as Alaska, Mexico, South and Central American countries, and even the Soviet Union, utilize the flyway. The Cowichan estuary is also a wintering area for many species of waterfowl which nest in northwestern Canada or Alaska (Lill et al., 1976). Up to 15,000 birds have been counted in a single survey in the estuary and vicinity. An estimated 16,000 waterfowl overwinter or stop during migration, at least 229 bird species utilize this area throughout the year (Trethewey, 1974). Twelve species of waterfowl are resident, and 2,500 - 4,000 waterbirds, such as loons, grebes, gulls, and cormorants, overwinter in Cowichan Bay. Great Blue Herons, gulls, and numerous shorebird species are resident on the foreshore.

In addition, the Cowichan wetlands provide overwintering habitat for a large population of Trumpeter swans and resident Mute swans. Various raptors, particularly bald eagle and Red-tailed hawk are also resident in the estuary.

In the Duncan - Cowichan Bay area, bird populations have been estimated (ELUCS, 1980; Blood et al., 1976) as follows:

- 16,000 waterfowl use the area for migrating or wintering habitat,
- 2000 - 4000 water birds, and
- 140 raptors

In the Cowichan estuary, data from weekly bird counts in 1973-75 provide an approximate indication of bird populations in the study area (Appendix 2, Blood et al., 1976). The maximum mean number of birds per weekly count were:

- 2202 waterfowl including Canada geese, swans, dabbling duck and diving duck species;
- 2418 water birds including loons, grebes, cormorants, herons, rails, coots, gulls, alcids;
- 54 raptors, including bald eagles and Red-tailed hawks.

More recent surveys of swans indicate a peak winter count of 194 adult and 20 juvenile Trumpeter swans and 75 adult and 20 juvenile Mute swans (Morrison, 1988)

These are conservative estimates of the maximum observed bird populations at any one time. The actual number of birds using the estuary over the course of a year will be considerably larger.

It is not possible to estimate the potential capability of the wetlands to support bird populations. However, the habitat is well below its theoretical carrying capacity for most species of birds.

5.3 Recreation

The Cowichan wetlands are principally used by recreationists for bird watching, nature interpretation, walking and hunting. Sport fishing in Cowichan Bay is the other major category of recreation which is dependent upon the resources of the estuary.

Visitors to the wetlands participating in nature-viewing activities are generally residents of Cowichan Bay, Duncan, Victoria or Nanaimo, although some tourist use also occurs. Members of naturalist groups in Cowichan Bay and Victoria are regular users of the wetlands. There are no organized facilities for accommodating visitors and the area is not publicized as a wildlife viewing or nature interpretation site.

Habitat biologists and naturalist groups have provided observations on recreation use. There are about 10 people who visit the wetlands on weekdays and about 15 people on weekend days, totalling about 80 visitor days per week who are viewing wildlife and/or hiking. The occasional organized group also visits the estuary. The present nature-viewing use of the wetlands is therefore approximately 4200 visitor days per year.

Hunters also use the wetlands north of the causeway during the Fall season. Waterfowl hunting in 1974-75 was estimated at 700 hunter days (Appendix 10, ELUCS, 1980). Other hunting areas in southern Vancouver Island have been closed in recent years, increasing the pressure on Cowichan estuary. In 1988, an estimated 1500-2000 hunter days occurred in the area (Horncastle, 1988).

The Cowichan wetlands have substantial potential for increased wildlife-viewing recreation. A survey of non-hunting wildlife activities indicated that on Vancouver Island, 24.9% of residents participate in activities where the main purpose of the outing is to engage in recreation that directly involves the non-consumptive use of wildlife (Reid et al., 1986). These activities particularly involved viewing waterfowl (72.9%), raptors (48.3%), songbirds (53.4%) and other birds (62.7%). Applying this participation rate to the population of the Cowichan Valley Regional District, the Cowichan wetlands could have an annual number of visitors of over 13,000. There is also potential for increased use from Victoria area residents and from non-resident tourists (1987 Vancouver Island estimate: 484,000 visitors).

A three-fold increase in wildlife-viewing recreation use to 13,000 annual visitors to the wetlands is possible, given certain improvements to facilities and reasonable promotion of the site. The potential number of hunter days is presumed to remain relatively constant at 2000 annually.

5.4 Water Quality

There are a number of pollution sources in the Cowichan estuary related to domestic sewage, agriculture, log handling and storage, and shipping and recreation. Concerns over sewage pollution are related to contamination by coliform bacteria, BOD loading, and chlorine residues. Concerns over log handling and storage are related to toxic leachates originating from wood wastes deposited on the Doman sawmill property. The toxicity of chlorophenols used in wood preservatives has been a specific water quality concern in the Cowichan estuary (cf. The Vancouver Sun, Dec. 15, 1988). The role of the Cowichan estuary wetlands in assimilating and treating pollutants has not been specifically investigated. However, there is considerable scientific evidence that natural and constructed (artificial) wetlands are efficient at treating both domestic and industrial wastewater (Reddy and Smith 1987).

The major water quality concern in the Cowichan wetlands is fecal coliform levels associated with upstream sewage discharge and agricultural run-off. The Bay is closed to shellfish harvesting due to such levels, although coliform levels are within standards for recreational use.

There are no existing data on the relative capacity for the different estuarine wetland habitats found in the Cowichan to assimilate and treat the various kinds of pollutants found there. Nevertheless, several generalizations can be made about the criteria needed to maximize the treatment capacity of wetlands.

1. Plant species such as cat-tail and bulrush, which have a large below ground biomass are generally most effective at removing contaminants from wastewater. Thus, Cowichan wetlands supporting *Carex spp.*, *Scirpus spp.*, *Juncus spp.*, and *Typha latifolia* should be considered as most important in the potential treatment of pollutants.
2. Retention time is an important factor in the effective treatment of pollutants by wetland plants. Thus, areas in the Cowichan wetlands where the longest water residence time occurs would be best for the treatment of pollutants. Hydraulic and dye tracer studies conducted in Netarts Bay, Oregon, showed that areas with a long water retention period (days) occur in upper regions of tidal drainage systems and upper marsh areas (EPA, Corvallis Environmental Research Laboratories, Unpub, Data, 1978).

6.0 EVALUATION OF WETLAND FUNCTIONS

In order to provide an indication of the relative contribution of wetland habitats to the production of wetland functions, and to assist in valuing such functions, a quantitative analysis is provided for each of the selected wetland products.

Two rating scales are used to evaluate the wetland habitats: a habitat capability rating and a habitat scarcity rating.

The habitat capability rating was determined by first prioritizing the habitat types in terms of their relative importance for the function and then rating the individual habitat capability on a scale of 1-5. Various criteria were considered in this rating, including productivity and food abundance, species access to and general preferences for habitat types, recreational access and features, and vegetation and water retention variables affecting water quality renovation.

The habitat scarcity rating was determined by considering the amount of habitat type available in relation to the other habitat types in the estuary. This rating recognizes that a diverse supply of habitats is as important as habitat productivity or capability factors for various wetland functions. Wetland environments are inherently complex and maintaining a diversity of habitats and relationships between habitat types is important to the overall functioning of the wetland system.

The evaluation of wetland functions in relation to habitat types is presented below. The total ratings for fish, wildlife and recreation were determined by multiplying the capability rating and the scarcity rating. The rating scale is as follows:

Capability Rating:	5 = high capability
	3 = moderate capability
	1 = low capability
Scarcity Rating:	5 = <5% of the total habitat
	3 = 5 - 20% of the total habitat
	1 = >20% of the total habitat

6.1 Fish Habitat

Juvenile salmon rearing and feeding habitat can be rated and prioritized based on the combination of the following two assumptions, which have been discussed in Section 5.1:

- (1) The importance of rearing and feeding habitat is positively correlated with the ease of access and duration of residence for juvenile fish. Thus the order of importance of Cowichan estuary habitats would be:

River Channel > Brackish Shallow Water > Submerged Vegetation > Mud and Sand > Low Marsh > High Marsh > Marsh & Pond > Riparian

- (2) The importance of rearing and feeding is also positively correlated with overall productivity and abundance of food organisms. The order of

importance of habitats related to the production of food items for juvenile salmon appears to be as follows:

Low Marsh > Submerged Vegetation > High Marsh > Brackish Shallow Water > Marsh and Pond > Mud and Sand > Riparian > River Channel

The derivation of the order of importance of rearing and feeding habitat, shown in Table 2, was based on a combined rating of habitat accessibility and food abundance. The final relative order of importance for fish rearing and feeding habitat is as follows:

Submerged Vegetation > Low Marsh > Brackish Shallow Water > High Marsh > River Channel > Mud and Sand > Marsh and Pond > Riparian

It must be emphasized that the above habitat rating is based on a very simple method of prioritization. The many complex interrelationships between the habitats are not considered. For example, the loss or change of one habitat type may significantly affect the value of another.

The rearing and feeding value of the Cowichan habitat types identified in this study contribute to the overall productivity of fish populations dependent on these habitats during some part of their life history. It is recognized that juvenile salmon depend on the wetland habitats during their estuarine residency period before leaving the Cowichan River system. Relative values have been assigned to various wetland habitat types since some habitats are more important than others with respect to fish rearing and feeding. However, the quantitative relationships between habitat area and salmon production is unknown. Because of this uncertainty, any quantitative evaluation of juvenile salmon habitat is largely based on professional judgement.

The habitat rating data provides a means of evaluating the effects of habitat disturbance in relation to the abundance and diversity of other habitats in the wetlands. The data can also be carried a step forward to measure loss of fish production function. For the purpose of this study, a worst case scenario is assumed where any change in the amount of wetland habitat has a direct influence on salmon production in the Cowichan system. This worst case scenario also must

Table 2 - Rating of Fish Habitat.

Habitat Type	Capability Rating	Scarcity Rating	Total Rating
Riparian	1	5	5
Marsh & Pond	1	3	3
River Channel	3	3	9
High Marsh	3	3	9
Low Marsh	5	3	15
Mud & Sand	1	1	1
Subm. Vegetation	5	5	25
Brackish Shallow	3	3	9

Rating Scale: Capability Scarcity
 5 = high 5 = <5%
 3 = medium 3 = 5-20%
 1 = low 1 = >20%

Capability Rating - Relative ease of access by juvenile salmon into habitat and relative amount of food items known to occur in the habitat

Scarcity Rating - Relative abundance of habitat type

assume that all other factors (spawning success, egg to fry survival, ocean survival, fishing harvest, etc.) remain constant and that there are no feedback mechanisms or compensatory factors. Given these assumptions, the capability of each wetland habitat to produce salmon is used to assess impacts on chinook, chum, coho, and steelhead in Section 11 of this report.

6.2 Bird Habitat

General habitat types for birds have been identified in the lower Cowichan Valley (flooded fields and swamps, lakes, estuary, small deep marine bay, and open coastline) (Blood et al., 1976). Species preferences for different habitats are summarized in broad terms on Figure 9, from Blood et al., 1976. Concentrations of birds tend to be located away from the industrial sites in the estuary, although no precise data are available on habitat preferences.

Wetland habitats vary in their suitability for various species. The backshore marshes are important migration, wintering, and nesting habitat. Dabbling ducks, Canada geese and Trumpeter swans, coots and raptors are common to the backshore and riverine areas. Diving and dabbling ducks, swans, herons and various shorebirds are common to the intertidal areas. General priorities can be attributed to different habitats for bird populations in the Cowichan. A simple rating system can be used to reflect basic habitat functions. Two criteria or assumptions are adopted as a basis for rating bird habitat:

- (1) The importance of the habitat for bird populations is dependent upon the abundance and productivity of food sources.
- (2) Wetland habitats are generally more highly utilized and valued where they provide undisturbed loafing and resting conditions, cover and nesting sites for birds.

The order of importance of habitat types is assumed to be:

Marsh & Pond > High Marsh > Low Marsh > Riparian > Submergent
Vegetation > Mud & Sand > Brackish Shallow Water > River Channel

Table 3 provides a rating of the relative capability of habitat types to provide food sources and rearing habitat for bird populations. This table attempts to combine in a very generalized manner, various habitat factors important to migratory waterfowl, resident shorebirds and raptors in the Cowichan estuary.

This rating of bird habitat provides a frame of reference for assessing specific proposals for habitat alteration in relation to the total wetland bird habitat capability. Extending this approach in a procedure similar to the evaluation of fish habitat, and with the same caveats regarding unknown quantitative relationships between habitat and species populations, this table will be used in Section 11 to estimate cumulative impacts of development on birds and bird-related values.

6.3 Recreation Features

The major recreation features were grouped into areas of national, provincial, regional and low significance by the Cowichan estuary Task Force. The areas of national significance are associated with the Cowichan and Koksilah (north fork) Rivers that provide opportunities for canoeing and boating, angling and viewing of waterbirds. The areas of provincial significance are principally the intertidal areas which provide important wildlife viewing opportunities. The areas of regional and low significance are the agricultural, backshore and industrial areas.

The recreational attributes of the wetlands relate to the overall natural characteristics of the estuary and are therefore not easily separated into geographic units. Nevertheless, for the purposes of evaluation, some relative rating of recreational capability can be applied. Two criteria or assumptions are adopted:

- (1) The recreational uses in the Cowichan wetlands are dependent upon the wildlife and related landscape features provided by the wetlands.
- (2) Public accessibility is an important factor for recreational use of the wetlands. Accessibility of habitats can be ranked on the basis of a combination of physical attributes and land ownership characteristics.

Table 3 - Rating of Bird Habitat

Habitat Type	Capability Rating	Scarcity Rating	Total Rating
Riparian	3	5	15
Marsh & Pond	5	3	15
River Channel	1	3	3
High Marsh	5	3	15
Low Marsh	3	3	9
Mud & Sand	3	1	3
Submerg. Veg.	3	5	15
Brackish Shallow	1	3	3

Rating Scale: Capability Scarcity
 5 - high 5 - <5%
 3 - medium 3 - 5-20%
 1 - low 1 - >20%

Capability Rating - Relative amount of food items
 occurring in the habitat and
 relative lack of disturbance.

Scarcity Rating - Relative abundance of habitat type.

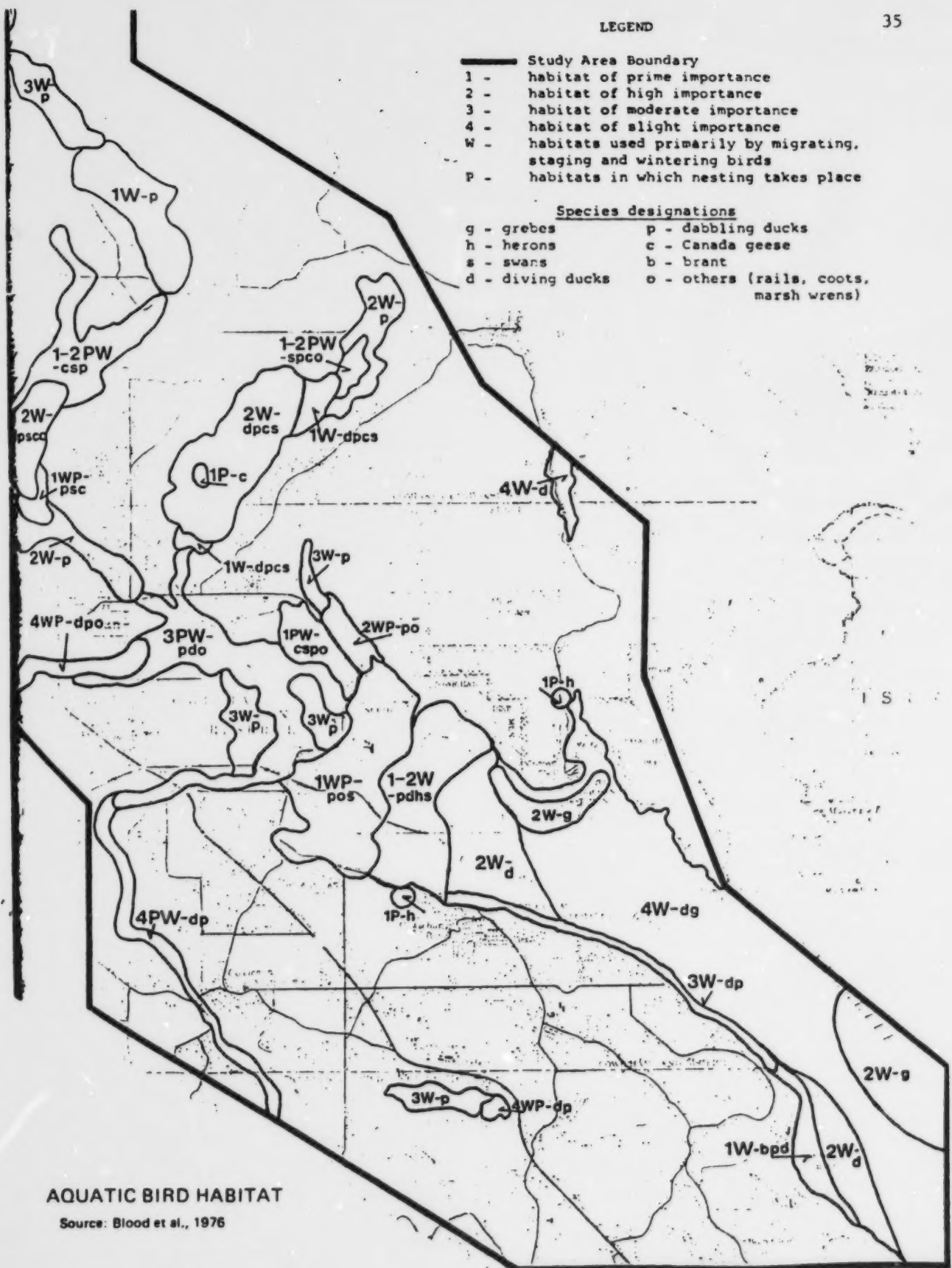


FIGURE 9

The overall ranking of habitat for recreation is as follows:

Riparian > River Channel > High Marsh > Marsh & Pond > Low Marsh > Mud & Sand > Brackish Shallow Water > Submergent Vegetation

Table 4 provides a rating of the wetland habitats, using the above two criteria. The dominant habitats for recreation are the riparian, and river channel, high marsh, and marsh and pond followed by low marsh and mud and sand. The river-oriented and high marsh recreational uses assume the continued availability of points or stretches of public access to these habitats. While access to the river channels is somewhat limited, they remain potential opportunities for improved boat launching sites for canoeists and the dykes provide reasonable access to riparian and high marsh habitats.

6.4 Water Quality Renovation

Rating estuarine wetland habitats with respect to their capacity to assimilate and treat pollutants is based upon two assumptions:

- (1) Vegetation with a well developed root and rhizome structure will be more important than vegetation with poorly developed roots. Non-vegetated habitats would be least important.
- (2) The most important habitats would also correspond with regions that have a long water retention time.

Thus, poorly flushed and thickly vegetated habitats such as Marsh and Pond, High Marsh, and Riparian are rated higher than Low Marsh and Submerged Vegetation and habitat which are better flushed and have less opportunity to treat pollutants. All remaining non-vegetated habitat types such as Mud and Sand, River Channel, and Brackish Shallow Water received the lowest rating.

The water quality renovation was evaluated somewhat differently from the other wetland functions. Table 5 shows how the combined rating values were derived. The productivity rating and the water retention rating were added (rather than multiplied), since the differences between habitat types capable of providing this

Table 4 - Rating of Habitat for Recreation

Habitat Types	Capability Rating	Scarcity Rating	Total Rating
Riparian	5	5	25
Marsh & Pond	3	3	9
River Channel	5	3	15
High Marsh	3	3	9
Low Marsh	1	3	3
Mud & Sand	1	1	1
Sub. Vegetation	1	5	5
Brackish Shallow	1	3	3

Rating Scale:	Capability	Scarcity
	5 - high	5 - <5%
	3 - medium	3 - 5-20%
	1 - low	1 - >20%

Capability Rating - Relative abundance of wildlife and related distinctive natural features and the opportunity for public access to the features..

Scarcity Rating - Relative abundance of habitat type.

Table 5 - Rating of Habitat Utilized for
Water Quality Maintenance

Habitat Type	Productivity Rating	Water Retention Rating	Total Rating
<u>Backshore</u>			
Riparian	5	3	8
Marsh & Pond	5	5	10
River Channel	1	1	2
<u>Intertidal</u>			
High Marsh	3	5	8
Low Marsh	3	3	6
Mud & Sand	1	1	2
Subm. Vegetation	3	1	4
Brackish Shallow	1	1	2

Rating Scale: 5 - high
3 - medium
1 - low

Productivity Rating - relative amount of belowground biomass.

Water Retention Rating - Relative contact time between ambient water and vegetation.

Table 6 - Capacity Factors for Water Quality Renovation

Habitat Type	Habitat Area	Rating	Renovation Capacity/40 Ha
Marsh & Pond	18	10	1 M gal per 40 ha
High Marsh	54	8	.80 M gal per 40 ha
Riparian	10	8	.80 M gal per 40 ha
Low Marsh	32	6	.60 M gal per 40 ha
Submergent Veg	5	4	.40 M gal per 40 ha
River Channel	42	2	not feasible
Mud & Sand	173	2	not feasible
Brackish Shallow	25	2	not feasible

359 ha

M gal = Millions of U.S. gallons

function were less pronounced than with the other wetland functions. Table 6 provides corresponding weighting factors for each rated habitat type which define the habitat function in terms of relative capability to process a volume of effluent for every 40 hectares. This rating method assumes that pollution sources are diffuse.

The capacity for the Cowichan wetlands to treat pollutants can be approximated by examining published data from artificial marsh systems designed to treat municipal wastewater. Since most of the domestic sewage entering the Cowichan system is from sewage lagoon effluent, published information will be listed from constructed marsh systems where sewage lagoon effluent was treated.

Based on results published by Crites and Mingee (1987), Reed et al. (1984), and Wolverton (1986), from 2 to 20 ha of constructed marshland was used to treat the equivalent of 1 million U.S. gallons per day of sewage lagoon effluent. There is also evidence that marsh plants are capable of treating toxic organic contaminants such as phenolic compounds (O'Keeffe et al., 1987; Seidel 1965).

Because of the variable water retention times of natural tidal wetlands, it was assumed that the Cowichan wetlands are only one-half as efficient at treating wastewater as the constructed marsh systems described above. It is therefore estimated that the most highly rated wetland habitat (marsh and pond) in the Cowichan wetlands are potentially capable of treating approximately 1 million U.S. gallons per day of sewage effluent in a wetland area of ca. 40 ha.

The capacity and values of the different habitat types to purify water contaminated with sewage and agricultural effluent and wood waste leachates (e.g. chlorophenols) can be estimated in accordance with Table 6.

7.0 POTENTIAL DEVELOPMENT PROJECTS

The following potential development projects were selected for the purposes of testing the wetland evaluation methods. Agricultural development at the backshore area of the wetlands and industrial development at the foreshore are representative of some of the major issues and development pressures within the estuary. The

Potential Port Expansion SCENARIO

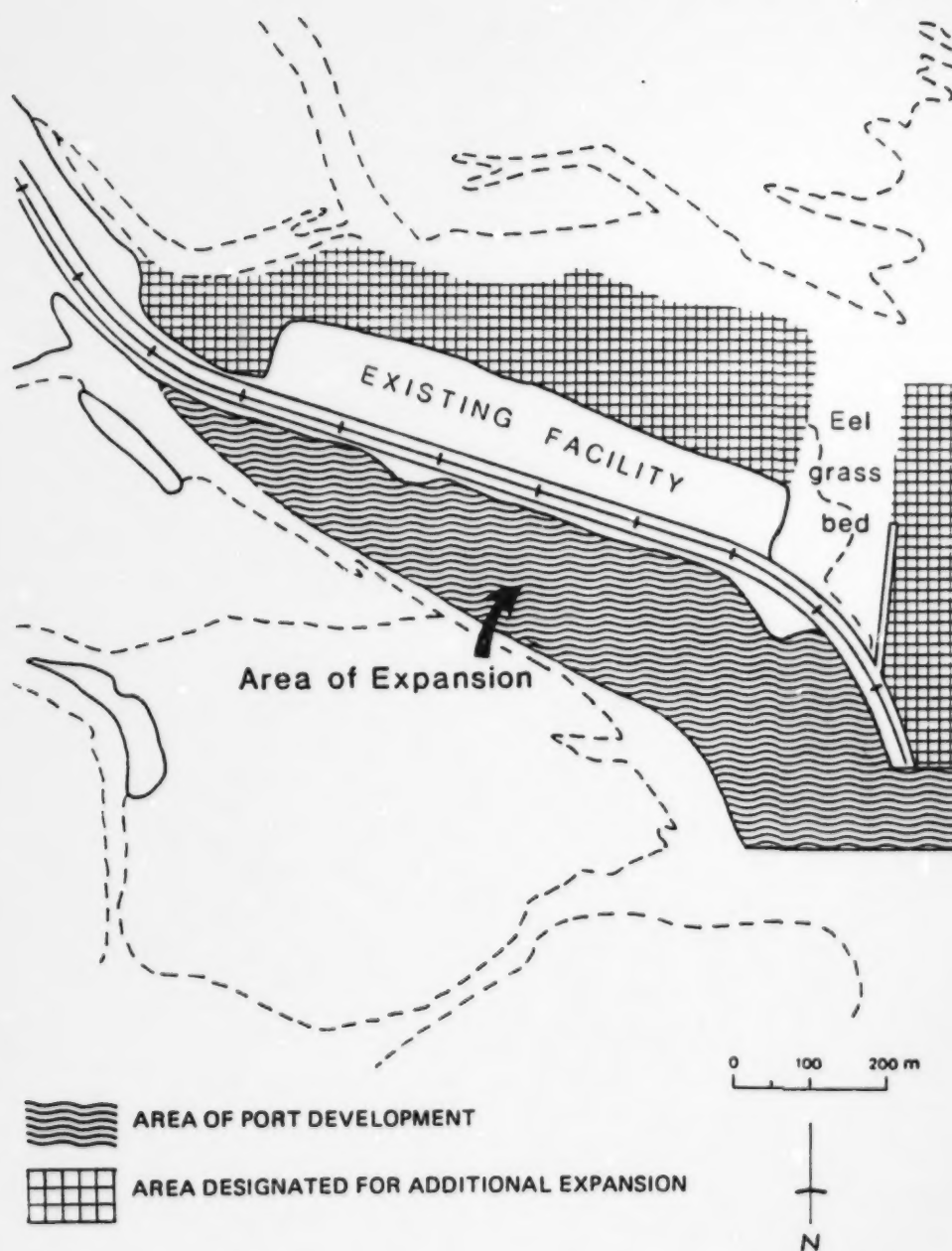


FIGURE 10

projects are hypothetical scenarios, although similar projects could occur in the future at various locations and with various dimensions.

7.1 Port Development Scenario

The Cowichan estuary Management Plan identifies an area within which future port expansion of port facilities could occur. A development site of approximately 20 hectares within this area was selected for evaluation purposes (Figure 10). The proposed development could involve berthing and storage facilities opposite the existing facility. A lumber storage area on the north side of the causeway presently operates at close to capacity. A wood chip loading facility also operates at the end of the south side of the port terminal.

The potential development would involve fill of the tidal area immediately east of this chip loading facility. It would provide industrial land for storage and handling of goods, in preparation for loading unto ships. Dredging would also be required to provide sufficient depth for ships. This is a site which is located away from the most sensitive intertidal area and involves a marginal addition to an existing industrial area.

7.2 Agricultural Reclamation

An area south of the Doman industrial area and north of the middle channel of the Cowichan River is designated for agriculture and "possible mixed use" (agriculture and wildlife conservation) in the Management Plan (Figure 7). This area, shown on Figure 11, presently contains some agricultural land surrounded by backshore and intertidal wetlands, portions of which are either daily or seasonally inundated with fresh or brackish water. Poor dyking along sections of the area allows for only seasonal use of much of the land for agriculture. The boundaries of the study site have been drawn to exclude the major intertidal channels but to include the intertidal flats, adjacent to existing agricultural land, which could be reclaimed. The site is approximately 17.5 hectares.

The potential development scenario would involve reclamation of the "mixed use" area for agriculture and enhanced protection of the existing agricultural use. The



AGRICULTURAL DEVELOPMENT
SCENARIO

FIGURE 11

reclamation could provide for development of a beef cattle and dairy farm operation on the site.

PHASE 2

8.0 STUDY METHODS

8.1 Economic Assessment

The Phase 1 section provided an overview of estuary habitats, functions and products and the inter-relationships of these bio-physical characteristics. The purpose of this Phase 2 section is to evaluate the relative merits of three specific evaluation methods: willingness-to-pay and opportunity cost methods which are economic indicators and cumulative assessment which encompasses both economic and environmental indicators.

In this study, the willingness-to-pay and opportunity cost methods are incorporated as part of an economic benefit-cost analysis, which is recognized by a number of government planning and regulatory agencies as a standard evaluation tool. Both willingness-to-pay and opportunity cost concepts are fundamental to the definition and application of benefit-cost analysis. For example, in the broadest sense, the net benefits of wetland preservation can be defined as society's overall willingness-to-pay for wetland preservation minus the willingness-to-pay for wetland development. Alternatively, wetland preservation benefits could be defined as the opportunity cost (or benefits to society which are foregone) of wetland development.

In application, the willingness-to-pay method is an attempt to simulate values for resources for which market prices do not exist, e.g. for wetland recreational activities. Therefore, at the applied level, willingness-to-pay values represent a subset of the overall opportunity cost of wetland development. Willingness-to-pay survey results are used in this study to value the recreational uses of the estuary such as bird-watching, hunting or sportfishing, which may be precluded by development. Commercial or food fishing values are estimated directly on the basis

of market prices as an additional opportunity cost of development. The opportunity cost of estuary preservation is also analyzed to provide an indication of the net economic loss associated with relocation or abandonment of proposed developments.

It is the view of the study team that both an overall and marginal perspective can be provided in wetland evaluation and therefore both are adopted in this study. For example, the overall economic value of the wetland as a whole provides some indication of the total value of wetland resources placed at risk by cumulative development. It also can be helpful in ranking the relative importance of a particular wetland in a regional context. However, unless the development entirely eliminates the wetland, the assessment of the merits and costs of any particular wetland project also requires consideration of project-specific or marginal resource losses.

All dollar values are converted to 1989 present values using a discount rate of 8% for illustrative purposes.¹ Only existing wetland values are measured although potential values (e.g. due to resource enhancement) are also discussed. *The purpose of the analysis is not to derive definitive estimates but to demonstrate the application of evaluation methods based on readily available data.*

8.2 Cumulative Assessment

The cumulative assessment method is based on the approach outlined in the Wetlands Are Not Wastelands interim report and in Manning et al., 1988. The method involves the evaluation of development proposals against a series of specific standards reflecting the range of applicable societal goals and objectives which are associated with or are served by wetlands.

Evaluation techniques which consider cumulative impacts are intended to take account of the additive and synergistic effects of an accumulation of environmental disturbances over time and space. They reflect the need to take a broad,

¹Virtually all wetland values are derived from resources or activities which are *renewable* indefinitely. The exception is preservation value which is usually measured as a one time willingness-to-pay. The present value of a constant annual stream of the resource divided by the discount rate.

comprehensive perspective of environmental change in relation to long term ecosystem management goals, as opposed to an ad hoc, single project perspective.

There are two important dimensions of cumulative assessment. First, it is necessary to have an adequate process which provides a thorough review of development projects and a context for negotiating the acceptability and design of development proposals. Second, a variety of methods of environmental assessment are required which capture the cumulative perspective and which provide information useful for decision making.

The Cowichan Estuary Management Plan provides both a process ("Procedural Guidelines Project Review Process") and broad goals and area designations for assessing individual projects. It provides the policy framework for long term management of the wetlands and minimizes uncertainty with regard to new developments. To a large extent, therefore, the plan preparation, implementation and amendment process provides the appropriate context for evaluating the accumulation of development impacts.

There is nevertheless, a need for methodological techniques and criteria for analyzing development proposals within the context and review processes of the Cowichan Estuary Management Plan. There is a particular need for methods which define the meaning of "significant" detrimental impact and which present information to assist project approval, mitigation and compensation decisions. These methods should address the difficult task of estimating the marginal effects of development proposals on wetland functions from a cumulative perspective.

A cumulative assessment approach ideally involves the consideration of:

- the overall supply, distribution and capability of wetland habitats to generate benefits to society and the allocation of such habitats for various land uses; (how much wetland is available, what type, what distribution and what suitability for alternative uses?)
- the existing and historical condition of wetland habitat and functions and the risks to wetland products and values from marginal increases in wetland

alienation or degradation; (how depleted or degraded is the physical resource and the products which depend upon the resource?)

- the specific environmental quality and resource management objectives, standards or guidelines relevant to the wetlands, which provide criteria for defining acceptable impacts (what are the goals of society and the objectives of technical standards?)

Cumulative impacts therefore, have a spatial, temporal and management context. The approach adopted in this study was to provide an array of information on wetland habitats, functions, habitats, products and values to assist decision makers in review of development applications. This framework offers a range of different types of biophysical and socioeconomic data and minimizes the dependence on any one set of data.

Table 7 presents a list of the criteria and indicators used in applying the cumulative assessment method to potential development scenarios in the Cowichan estuary.

TABLE 7: CUMULATIVE ASSESSMENT CRITERIA AND INDICATORS

<u>CRITERIA</u>	<u>INDICATORS</u>
1. <u>Economic Viability</u>	▪ Benefit-cost ratio
2. <u>Site Alternatives</u>	▪ Feasible alternatives in the region
3. <u>Regional Significance</u>	▪ Relative ranking of wetland in the region
4. <u>Aquatic Resources</u>	
a) Fish Habitat	▪ Habitat capability and diversity rating
b) Fish Stocks	▪ Existing fish production ▪ Potential fish production ▪ Potential fish impacts
c) Fishery Values	▪ Total economic value ▪ Potential economic losses
5. <u>Wildlife Resources</u>	
a) Bird Habitat	▪ Habitat capability and diversity rating
b) Bird Populations	▪ Existing bird populations ▪ Historical bird population ▪ Potential bird impacts
c) Wildlife Values	▪ Cost of enhancement ▪ Total wildlife recreation value ▪ Potential economic losses
6. <u>Recreation Resources</u>	
a) Recreation Habitat	▪ Habitat capability and diversity rating
b) Consumptive Recreation Use	▪ Hunter days annually ▪ Sport fishing days ▪ Potential impact
c) Non-consumptive Recreation Use	▪ Viewing and hiking use ▪ Potential impact
d) Recreation Values	▪ Total economic value ▪ Potential economic loss

TABLE 7: continued

<u>CRITERIA</u>	<u>INDICATORS</u>
7. <u>Water Quality</u>	
a) Water Quality Renovation Habitat	* Pollutant processing capacity
b) Water Quality Standards	* Potential impacts on standards
c) Water Quality Renovation Values	* Total potential economic value * Potential economic loss
8. <u>Education/Scientific Resources</u>	
a) Special Ecological Features	* Rare, endangered, unusual ecological components
b) Conservation Programs	* Ecological reserves * Pacific Estuary Conservation Program * Heritage Sites
9. <u>Land Use/Resource Management Objectives</u>	
a) Federal Policies	* Salmon management plan objectives * International waterfowl management agreements
b) Provincial Policies	* Cowichan Estuary Management Plan
c) Community Policies	* Official Community Plan

9.0 WILLINGNESS-TO-PAY SURVEY RESULTS

A willingness-to-pay survey to estimate local resident utilization and values of the Cowichan estuary was designed on the basis of the survey developed by Bardecki for the Ontario pilot study,² consultation with the client and study team experience with similar surveys. The survey questionnaire is provided in Appendix 1 to this report. Local residents are defined as those living within a 15 mile radius of the

²Valuing Wetlands: The Application of Willingness-to-Pay, Opportunity Cost and Cumulative Impact Methods to Greenock Swamp, Ontario, M.J. Bardecki, June 1988.

estuary. A survey of non-local resident values was not attempted for two main reasons:

- the poor response to the Ontario survey which suggested that utilization levels and values would be very low or zero except for very unique, well-known wetlands;
- the increase in sample size requirements due to the low response rate would have increased survey costs beyond the available budget.

Non-local values were not surveyed, although residents in Victoria and Nanaimo were surveyed to determine the level of awareness or use of the Cowichan estuary.

A random telephone survey was undertaken, rather than a survey of known user groups, to avoid possible biases in applying sample results to the area population as a whole. However, survey results were compared with estimates provided by user groups. With respect to the willingness-to-pay question itself, a "prompting" approach (i.e. initially suggesting value) was not used because of the difficulties in maintaining respondent interest and the experience in the Ontario study with starting point bias. Instead, an "open" question was used, providing the respondent with a frame of reference or comparison upon which to base a value, if necessary.

The willingness-to-pay values derived in this survey represent typical or average values associated with wetland use. These values must be used with caution in assessing project-specific impacts, since the level and nature of uses can vary greatly throughout the wetland and is not necessarily proportionate to an alternative approach of posing willingness-to-pay questions about specific developments was rejected. This would introduce the problem of even greater bias in value estimates since users may exaggerate responses in order to influence a perceived development decision. Much more survey time would also be required to describe the nature and location of the project. Also, respondents were not asked to what extent their visits to the estuary were incidental to other activities.

With respect to the survey of the local residents, there were 194 persons who participated fully in the survey (respondents). A further 36 were contacted but would not participate (non-respondents). Of respondents, 95% were aware of the

Cowichan estuary, its location and the types of wildlife and activities it supported. Forty-two or 22% of respondents made some use of the estuary in the past year.

The total number of visits to the estuary in 1989 by the respondents, estimated as the number of participants in various estuary activities times the average frequency of visits by activity, is estimated at 1,152 days. A large number of these visits were made by several nearby residents who went walking in the wetlands almost daily. Because of the very small sample and the nature of activities by these few individuals, it is considered that a more valid estimate would be derived by excluding these residents, resulting in total use of 308 visits by survey respondents. An even smaller estimate is derived on the basis of median values. The breakdown of activities presented in the table below shows that wildlife viewing and nature appreciation were by far the most common recreational activities in the estuary, regardless of the estimating method used.

	# Persons %		# Visits % (average) ^a		# Visits % (median) ^b	
Wildlife Viewing	16	38	720	63	144	59
Fishing	10	24	38	3	30	12
Hunting	3	7	17	1	18	7
Nature Appreciation & Other	13	31	377	33	52	21
Total	42	100	1,152	100	244	100

^aCalculated as the number of persons primarily engaged in the activity times the average number of visits by each person.

^bCalculated as the number of persons primarily engaged in the activity times the median number of visits by each person.

Of the non-respondents, 14 or about 40% did indicate they were not aware of the estuary. The remainder gave no indication at all, although it is considered likely that most of these were either not aware of the estuary or did not visit it. The treatment of non-respondents is a very important consideration when extrapolating survey results to the area population as a whole.

Of the 42 respondents visiting the estuary, 38 were able to place user values on their experience. The median value for all types of activities is \$15/visit. The average value is much higher at about \$34/visit, due to very high values estimated by a few respondents. It is not clear whether respondents with very high user values are providing actual values or are "strategic" values designed to sway perceived planning or development decisions. Eliminating only 5 respondents with values of \$100/visit or greater from the sample, results in an average value of \$17.70/visit.

Average user values by activity for all respondents are summarized below. These values are subject to outlier bias; ie. extremely high values by a few individuals who may be responding strategically.

	<u>Average \$/Visit</u>
Wildlife	15
Fishing	55
Hunting	19
Nature Appreciation & Other	41

Ninety-four percent of the respondents estimated an annual dollar sum they were prepared to contribute (over and above their user value) to preserve the estuary in its current state. The median and average preservation values for these respondents are \$25/year and \$78/year, respectively. The average value is much higher than the median because of very high values provided by a few respondents, which may again reflect some strategic bias in these responses. Preservation value estimates would be lower if non-respondents were assigned a preservation value of zero.

The local survey is considered to be too small to yield reliable results, particularly by type of activity, due to the influence of a few "outliers" who skew the utilization and value estimates considerably. The treatment of non-respondents is also very important in the interpretation and use of survey results. For illustrative purposes, total use of the estuary by the local area population is estimated by multiplying the average number of visits per person in the sample of 1.5 (adjusting the sample to exclude outliers and include in the sample those non-respondents who explicitly indicated they were not aware of the estuary) times the total local area

adult population.³ This yields a total of almost 38,500 visits to the estuary for various recreational activities, annually.

The total local user value of these visits, calculated by multiplying the overall average value/visit (excluding outliers) of \$17.70 by the total number of local visits, is approximately \$681,500/year, representing a present value of \$8.5 million at 8%. The total local preservation value for the estuary, calculated by multiplying the average preservation value/respondent of \$50 (excluding outliers and including "unaware" non-respondents) by the total local area population, is \$1.28 million/year, representing a present value of \$16 million at 8%. If survey results were extrapolated to local area population without any adjustments total user and preservation values would be much higher.

The above results exclude estuary recreational values by non-local residents. However, a survey of non-local (Victoria and Nanaimo) residents was undertaken to determine the extent of awareness and use of the Cowichan estuary in these much larger population centres, 157 persons responded to these questions. In addition, 10 persons were contacted but refused to participate. Of the respondents, 68 or 43% stated they were aware of the estuary and 4 or 2.5% indicated they visited the estuary in the past year. Although these use and awareness rates are much lower than for local residents, they are still significant in terms of the large populations from which these samples are drawn. Applying the "user rate" obtained from the Victoria/Nanaimo survey to the estimated adult population for these areas yields a total number of non-local estuary users of 9,675. This estimate is almost two times the number of local estuary users, although this factor would be much lower for user-days since the frequency of use by non-local residents would be much lower than for locals. Applying the "awareness rate" for Victoria/Nanaimo to total population yields a total of 166,000 non-local residents who may have a preservation value for the estuary. However, a greater proportion of non-local residents would be either unaware or not as familiar with the estuary, and therefore would be more likely to have zero or lower than local preservation values.

³Defined as the 20+ age group in Cowichan Bay, Duncan, Cobble Hill, Chemainus environs.

This survey is considered too small to yield reliable results, particularly by type of activity, due to the influence of a few "outliers" who skew the utilization and value estimates considerably. Even when outliers are excluded from the sample and non-respondents are assumed to be non-users, the survey generates estimates of estuary use which are orders-of-magnitude higher than observed by user groups and planners. A random survey could be expected to generate somewhat higher estimates since continual monitoring of the wetland is impossible. However, the survey estimate of over 100 visitors per day, on average, throughout the year, is clearly too high, particularly considering that use by non-local residents has not yet been included.

With respect to the value of recreation in the estuary, a number of willingness-to-pay surveys have been undertaken in B.C. for similar activities. One of the most useful for purposes of comparison is a 1983 survey undertaken by the Ministry of Environment (MOE) for wildlife activities in various regions of B.C.⁴ The survey, covering over 10,000 B.C. residents, estimated the average user value of wildlife activities on Vancouver Island at about \$14/day in 1989, a much lower value than average obtained in this survey but very comparable to our median or adjusted values. The surveys are not entirely comparable since the MOE study had a different type of user value question⁵ and also because it excluded the value of consumptive activities (e.g. fishing and hunting).

The MOE study also estimated a preservation value for current wildlife populations and types in B.C. of about \$67.50 annually. This is only slightly higher than our adjusted estimate for the Cowichan estuary itself.⁶ Even though our survey does indicate that preservation values for the estuary exist over and above user values, it appears that people cannot attribute their general environmental "budget" to particular areas or issues. The use of preservation values in quantitative economic

⁴MOE, Report on the British Columbia Survey of Non-Hunting and Other Wildlife Activities for 1983, 1986.

⁵Respondents were asked how much annual expenditures on wildlife would have to increase before deciding not to participate.

⁶The MOE survey "capped" preservation values at \$2000/year.

evaluations for a specific wetland should, therefore, be used with caution because these values cannot be directly attributed to the wetland.

10.0 OPPORTUNITY COST ASSESSMENT

10.1 Opportunity Cost of Cowichan Estuary Development

The opportunity cost of developing the Cowichan estuary is assessed from two perspectives: firstly, the overall value of the estuary as a whole (section 10.1.1) and secondly, the loss in value resulting from a specific development in part of the estuary (section 10.1.2). An attempt is made to value existing resources currently supported by the estuary. Potential values which could be placed at risk by estuary development are discussed in section 10.2. Generally, market prices are used to evaluate commercial resources or projects. Utilization and willingness-to-pay surveys (by the study team and others) are used as available and appropriate to value recreational activities.

10.1.1 The Overall Value of Existing Cowichan Estuary Resources

The overall economic value of the Cowichan Estuary is derived from the four main functions of the Cowichan Estuary described in Phase 1:

- fisheries habitat;
- bird and other wildlife habitat;
- other recreational features or amenities; and
- water quality renovation.

These habitat functions and recreational amenities contribute to or generate the following values:

- commercial, sport and Native food fishing;
- hunting;
- other non-consumptive recreational activities such as birdwatching, boating, hiking and nature appreciation;
- other values such as water quality, research and education.

Each of these values are described below and then the extent to which they can be attributed to the estuary is estimated.

Fisheries Values

A recent study by the B.C. Ministry of Environment and Parks⁷ estimates that the Cowichan-Koksilah river system produces an annual average commercial salmon harvest of about 180,000 pieces. The proportion of these stocks attributable to the Cowichan estuary represents an annual net commercial value of about \$1.8 million in 1989.⁸ The recreational harvest of Cowichan-Koksilah salmon, steelhead and searun cutthroat over a similar period is estimated at about 96,000 pieces, supporting thousands of recreational fishing-days. The overall willingness-to-pay for fresh and saltwater angling supported by Cowichan-Koksilah (taking into account the estuary dependence of each species) has been estimated independently of this study at about \$2.3 million annually.⁹ The study team's survey resulted in a willingness-to-pay value of about \$260,000 annually, based on an average of about 4,700 fishing-days¹⁰ in the estuary at \$55/day. This value is relatively minor since it represents only a portion of freshwater angling values and excludes saltwater angling. Therefore, the independent estimate of total sportfishing values is chosen for purposes of this analysis. The Native food fishery on the Cowichan-Koksilah system is estimated by DFO¹¹ at about 13,000 pieces annually, representing about \$233,000 per year in net wholesale value.¹² The total net present value of

⁷Ministry of Environment and Parks, Cowichan-Koksilah Water Management Plan, September, 1986.

⁸Net Value is equal to wholesale commercial value less processing and harvesting costs estimated by the DFO Economics and Planning Branch for its SEP Benefit-Cost Model. Net annual commercial value by species is \$ 805,000 for chinook, \$ 405,000 for chum and \$ 616,000 for coho.

⁹Ministry of Environment & Parks, op. cit.

¹⁰Estimated as the average number of fishing days by survey respondents times the local area population.

¹¹Values and costs based on SEP Benefit-Cost Model.

¹²Net value (ie. gross wholesale value less harvesting and processing costs) based on SEP Benefit-Cost Model.

commercial, sport and Native salmon fisheries at an 8% discount rate¹³ is estimated at about \$54.2 million.

Crab is the other significant fishery supported by the Cowichan estuary. Currently there are 4 commercial crab vessels harvesting about 10,000 kg. of crab annually near the estuary in Cowichan Bay. Assuming all of these crab stocks are supported by the estuary, this represents a net wholesale value of about \$30,000/year and a present value of \$375,000 at 8%.¹⁴ Crab is also taken in the recreational and native food fisheries, although no catch or effort estimates are available.

Total fisheries values attributable to the Cowichan estuary are summarized below.

	1989 Present Value in \$1989 @ 8% (\$ millions) *		
	Salmon	Crab	Total
Commercial Fishery	22.5	0.4	22.9
Sport Fishery	28.8	n.a.	28.8
Native Food Fishery	2.9	n.a.	2.9
Total	54.2	0.4	54.6

* The present value of each fishery equals the annual willingness to-pay or net commercial value divided by the discount rate.

¹³The discount rate is an important economic evaluation issue in itself, and is discussed below. This rate is assumed for illustrative purposes only.

¹⁴Catch estimate based on average effort and catch data for Statistical Area 18. Net value estimate based on most current wholesale prices available (1987) and assumption that harvesting and processing costs compromise 50% of wholesale value.

Hunting Values

There are several estimates of hunting utilization of the Cowichan estuary. The local Conservation Officer¹⁵ estimated that in 1988, there were about 1500-2000 days of waterfowl hunting activity in the estuary area. The study team's survey yields an estimate of about 2,100 hunter days.¹⁶ Although the study team survey estimate is based on a very small sample, it is consistent with this independent estimate. The study team's willingness-to-pay survey resulted in a value of \$19/hunter day. No other value estimates were readily available.

Combining these utilization and willingness-to-pay estimates results in a range of annual hunting values for the estuary of about \$29,000 to \$40,000, representing a present value of \$360,000 - \$500,000 at a 8% discount rate. It is assumed all of these hunting values are attributable to the estuary.

Nature and Wildlife Viewing Activities

Based on estimates provided by habitat biologists and naturalist groups, the current nature viewing use of the estuary is estimated at about 4,200 visitor-days per year. The study team's own survey resulted in a much higher estimate of about 33,000 visitor-days per year, excluding non-local residents.¹⁷ One could expect random survey results would exceed estimates by nature clubs, since a survey would include wildlife enthusiasts who are not members of clubs. However, the survey results are not considered to be realistic (i.e., 90 visitors per day) and the lower estimate is used in this analysis.

The average value of wildlife viewing in the study team's survey is about \$21/day. A province-wide study of non-hunting recreation by the Ministry of Environment,¹⁸

¹⁵Personal communication with G. Horncastle, B.C. Ministry of Environment, See Phase 1 report.

¹⁶Average number of hunter visits/person in the adjusted sample times the local area adult population.

¹⁷This estimate also excludes "outliers" and is based on an adjusted sample. As noted above, without these adjustments, estimated estuary use would be much higher.

¹⁸MOE, op. cit.

estimated a value of about \$14/day for such activities in \$1989. Based on the lower use and value estimates described above results in nature and wildlife viewing values in the Cowichan estuary of about \$46,000 annually, representing a present value of \$575,000 at a 8% discount rate.

Water Quality Values

As noted in Phase 1, the Cowichan estuary has a substantial capacity to assimilate and treat pollutants. There is no direct use (e.g. residential or industrial) of water flowing through the estuary or downstream from it. The existing value to society of the estuary's water treatment capability is reflected primarily in the quality and abundance of fisheries and wildlife resources which the estuary habitat supports. Water quality is particularly important for relatively sedentary species such as crab. These water quality values are incorporated into the overall value of estuary-dependent fisheries and wildlife, which have been estimated above. In addition to these existing resource values, there are potential benefits which could be derived from future use of the wetlands for treatment of sewage effluent, as discussed in Section 10.1.3.

Other Values

Other social values of the estuary include ecological values (e.g., preservation of flora and fauna gene pools) and providing an opportunity for scientific research and education. Ecological values are at least partly captured by the preservation value estimated above. However, as noted above, it is difficult to apply such values in a quantitative analysis. Research and education values are not measured in this study, but could be estimated, in principle, by willingness-to-pay methods. It is likely that measurable user or preservation values for estuary-related science and research are small in relation to commercial resource values and recreational activities attributable to the estuary.

10.1.2 Total Resource Values Attributable to Existing Estuary Resources

Based on the above resource values, the total value attributable to existing Cowichan estuary resources is estimated at \$55.6 million, or about \$114,000/hectare, in present value terms broken down as follows:¹⁹

1989 Present Value @ 8% (\$ millions)	
Fisheries	
Commercial	22.9
Recreational	28.8
Native	2.9
Hunting ^a	0.4
Nature and Wildlife Viewing	0.6
TOTAL	55.6

^a Mid-point of range of values estimated.

It is interesting to compare the sum of estuary resource values with other, aggregate measures of estuary value. One such measure is actual purchase prices for estuary lands. Discussions with the Nature Trust of B.C. (a non-profit organization established to preserve and purchase wetlands and other natural habitats throughout the province) indicates that actual purchase prices for Cowichan estuary properties have ranged between \$7,000 to \$12,000 per hectare. These values, based on appraised values, are much lower than the resource-based estimates derived above. This is not unexpected since many of these resource values are social benefits not captured by individual owners but lost to society if alternative uses of the estuary occur.

¹⁹ These estimates are based on the assumption that the value of estuary resources and recreational activities remain constant in real terms over time.

10.1.3 Potential Estuary Values

Potential increases in estuary values should be considered when estimating the overall value of the estuary. Estuary values could increase due to:

- natural growth in estuary recreational activities;
- resource enhancement, or;
- future increases in the relative value society places on estuary resources.

The potential fisheries values generated or supported by the Cowichan-Koksilah system can be significantly greater than current values due to enhancement initiatives. Discussions with Department of Fisheries & Oceans officials²⁰ indicate that the habitat on this system has a much larger productive capacity than is presently being utilized. For example, through smolt release programs and appropriate fisheries management measures, DFO plans to increase harvestable chinook production in the system by about 11,000 pieces/year by 1995. Assuming for simplicity that all of this incremental production were harvested in commercial fisheries,²¹ the net present value of additional salmon production would be approximately \$5 million. However, enhancement costs should be netted out of this estimate.

As noted in section 5.3, the Cowichan estuary may have potential for increased wildlife viewing recreation. Based on estimates by user groups of current recreational use in the estuary,²² and data reported in the Ministry of Environment study regarding participation by Vancouver Island residents in non-hunting wildlife activities,²³ there could be an increase of 8,000 visitors per year to the estuary.

²⁰Personal communication with B. Riddell, Pacific Biological Station, Nanaimo, B.C.

²¹The value of additional salmon production in Native food and sport fisheries could be higher or lower than in the commercial fishery depending on a number of factors such as food fish harvesting costs and the effort response of anglers to increase in their catch.

²²MOE, op.cit.

²³MOE, op. cit.

However, due to uncertainty in estimates of current use and in the number of visits per person, the value of this recreational potential is not estimated here. If this data could be confirmed, the increase in value could be calculated easily, in principle, as the present value of the potential annual increase in user value.

The estuary may generate additional potential benefits if it could treat sewage discharges from local communities at lower cost than conventional systems. The net benefit would be estimated as the present value of deferring or avoiding costs of conventional new waste treatment facilities less costs such as wetland dyking and streamflow diversion. Wetland treatment of sewage is apparently quite cost-effective compared to conventional treatment systems, even in cases where new wetland had to be "constructed."²⁴ Further benefits could result if estuary treatment contributed to reduced coliform counts to levels warranting the lifting of the current shellfish ban in the area. Prior to the implementation of this ban in 1973, an area on the south shore of Cowichan Bay supported commercial, recreational and Indian clam fisheries. The commercial component of this harvest is estimated at about \$22,000 annually,²⁵ representing a present value of \$275,000 at 8%.

The value of the estuary could increase through time even if there were no increase in the wildlife resources or recreational activities supported by the estuary. There could be a real increase in the relative value society places upon the estuary in its current state due to increasing scarcity of resources and wildlife experience (particularly nearby large population centres) and increasing public awareness of the importance of the Cowichan estuary as a wildlife habitat. Although not estimated in this study, rates of growth in estuary values could be easily incorporated as an adjustment in the present value calculations, for example, as sensitivity cases.

²⁴See Crites, R.W., T.J. Mingee, Economics of Aquatic Wastewater Treatment Systems, 1987.

²⁵Cowichan Estuary Task Force Report, op. cit.

10.1.4 Resource Losses Resulting from Development

Losses of Existing Estuary Resources

The potential impacts of hypothetical estuary development on existing estuary fisheries resources were estimated by the study team on the basis of the habitat rating method described in Section 6. Applying these losses to commercial and recreational fisheries values estimated in Section 11, yields total annual dollar losses of about \$82,000 and \$36,000 for port development and land reclamation, respectively.²⁶ This is equivalent to a present value of \$1 million for port development and \$450,000 for land reclamation at 8%. Note that recreational losses are based on the assumption that for every 1% decline in sport catch, recreational angler-days decreases by 0.5%. This less than proportionate response is consistent with other, more detailed studies of sportfishermen's responses to changes in success rates.²⁷

Other recreational losses were estimated in the same manner as above. These losses are almost negligible if based on the estimates of hunting and wildlife viewing uses by nature groups and managers, and on the assumption that declines in habitat rating or wildlife populations will have a less than proportional affect on recreational uses. In principle, the water quality impacts of the proposed developments could further reduce fish and wildlife populations and values over and above the impacts of habitat alienation, although such impacts could not be quantified.

²⁶Annual fisheries losses are calculated for each species fishery as the percentage fish habitat rating impact (3.2% for port development and 1.4% for agricultural development) times the annual commercial and recreational values for each species, times the species dependence on the wetlands (100% for chinook and chum, 50% for coho, and 25% for steelhead and cutthroat). Losses in recreational values are assumed to be 50% of the actual decline in sport catch. As an example, the annual impact of port development on chinook commercial fisheries is estimated as $.032 \times$ annual net wholesale value of \$ 805,000 $\times$ a species dependency factor of 100%.

²⁷See, for example, Marvin Shaffer & Associates Ltd., "Analysis of the Economic Efficiency Impacts of Alternative Recreational And Gulf Troll and Chinook Allocations in the Gulf of Georgia," for DFO, 1987.

Losses to Potential Estuary Values

Some portion of future estuary resource values could be placed at risk by, and therefore represent an additional opportunity cost of estuary development. Estimates are not developed here due to data uncertainties.

10.2 Opportunity Cost of Cowichan Estuary Preservation

The opportunity cost of estuary preservation depends upon the availability and economics of alternative locations for the development that might otherwise have taken place in the estuary. For projects which are not feasible at a non-estuary site, the opportunity cost of estuary preservation equals the total net benefits associated with the project itself. For projects which have feasible alternative locations the opportunity cost of estuary preservation is the increase in cost associated with relocating developments to non-estuary sites. For projects which are not feasible at all or which have equally viable alternative locations, the opportunity cost of estuary preservation is zero.

With respect to the land reclamation project, discussions with the District Agriculturalist indicate there is a surplus of agricultural land in the immediate area with equal or higher potential for dairy or beef farming than the proposed reclamation site. Furthermore, on non-estuary sites there would be no investment required for dyking and drainage. The cost of dyking for the property in question is estimated at over \$300,000. In fact, the present value of the increase in forage production over time would not repay the costs of dyking, assuming an 8% discount rate.²⁸ For these reasons, the opportunity cost of wetland preservation is considered to be negligible.

The opportunity cost of disallowing port expansion is more difficult to assess. Data from the current port operation could not be obtained due to sensitivities concerning negotiation of the purchase of Lot 160. There are a number of alternative sites or locations on eastern Vancouver Island from which increased volumes of lumber and woodchips could be shipped. For example, Ogden Point in

²⁸Cost and incremental production value data are based on a Ministry of Environment memo regarding the proposed dyking of Dinsdale farm in the Cowichan estuary. A.A. Brown to J. Wester, Water Management Branch, June 19, 1984.

Victoria has an existing deep water terminal which could handle substantial increases in tonnage. There would be some additional transport costs associated with this alternative. Also, this would involve the trucking of forest products through the Victoria city centre, which is time consuming and disruptive. There is serviced vacant land at the Duke Point industrial park near Nanaimo, with deep water access. A new dock facility would likely be required but this would be offset by the avoidance of landfill costs. There is also industrial land with some deep water loading facilities at the former cement production plant at Bamberton. However, local residents are generally opposed to new industrial uses. Transportation costs to Bamberton and Nanaimo may also be somewhat higher than for the Cowichan port.

In summary, the disallowing of port expansion in the estuary is not likely to preclude additional lumber or wood chip shipments from Vancouver Island, given the number of alternative sites. However, rerouting of these shipments would likely result in increased transportation costs and perhaps additional capital costs. These costs would have to be compared with estuary values foregone due to port expansion.

11.0 CUMULATIVE ASSESSMENT

The cumulative assessment data are presented below in accordance with the criteria outlined earlier on Table 7. To assist in identifying impacts of development, a simple matrix of the interactions between development components and the physical, biological and social functions of the wetlands was prepared. Tables 8 and 9 summarize the major interactions which would normally be considered in a formal impact assessment. The potential impacts are described below in terms of cumulative assessment criteria.

The wetland habitat types affected are as follows:

Table 8: Port Development Interaction Matrix

Development Components	Wetland Functions	
	Physical	Social
1. Water column	- sedimentation - productivity - dilution capacity	- fish utilization - bird utilization - crab/salmon fishery - bird populations
2. Substrate	- habitat loss - benthic reduction	- fish utilization - crab/salmon fishery
3. Sediments	- poss. toxicity - water quality	- fish mortality - crab/salmon fishery
4. Dredge spoil	- poss. toxicity - water quality	- fish mortality - crab/salmon fishery
5. Hydraulics	- lateral circulation - productivity	- fish utilization/migration - juvenile salmon rearing - crab/salmon fishery
6. Channel depth	- salinity gradient - vegetation - vertical circulation - productivity	- fish utilization - crab/salmon fishery
7. Filling	- habitat loss - benthic reduction	- fish utilization/rearing - crab/salmon fishery
8. Armouring	- habitat alteration	- fish rearing habitat - crab/salmon fishery
9. Ship traffic	- boat wash - vegetation	- productivity - fish utilization - crab/salmon fishery
10. Truck traffic	- noise/disturbance	- bird populations - bird populations - recreation
11. Spill risks	- water quality	- fish mortality - bird mortality - crab/salmon fishery - bird populations
12. Surface drainage	- water quality	- fish mortality - bird mortality - crab/salmon fishery - bird populations
13. Aesthetics	- industrial use - landscape	- fish & wildlife populations - recreation

Table 9: Agricultural Reclamation Interaction Matrix

Development Components	Wetland Functions		
	Physical	Biological	Social
1. Instream works	- sedimentation - productivity	- fish utilization - bird utilization	- salmon fishery - birds/recreation
2. Hydraulics	- channel constriction	- fish migration/rearing	- salmon fishery
3. Dredge spoils	- poss. toxicity - water quality	- fish mortality	- salmon fishery
4. Draining	- vegetation - nutrient flows - productivity - back channel displacement	- fish & wildlife populations - bird migratory habitat - bird nesting sites - juvenile salmon rearing - salmon migration nesting	- recreation - bird populations - salmon fishery
5. Armouring	- riparian vegetation - water temperature - cover/shading - detritus	- fish mortality - bird utilization - fish & wildlife food sources	- salmon fishery - bird populations - recreation
6. Revegetation	- vegetation productivity	- bird utilization	- bird population
7. Agri. wastes	- water quality	- fish mortality	- fisheries - recreation
8. Farming	- habitat displacement	- bird utilization	- bird populations
9. Access	- development	- bird stress/mortality	- bird population
10. Aesthetics	- landscape alteration	- fish & wildlife populations	- recreation

	<u>Agricultural Development</u>	<u>Port Development</u>
Riparian	1 ha	-
Marsh & Pond	1.4 ha	-
High Marsh	4.6 ha	-
Mud & Sand	-	16 ha
Brackish Shallow	-	4 ha
(Agriculture)	<u>10.5 ha</u>	<u>-</u>
	17.5 ha	20 ha

Economic Viability

The economic viability of the development projects was discussed in Section 10 above. The dyking costs exceed the potential returns from increased forage production. The port development may be viable but the opportunity costs of foregoing developing are relatively minor.

Site Alternatives

There are some twenty port industrial sites on eastern Vancouver Island, not all of which have been approved or developed for industrial use. The most likely alternatives having available deep-water access for port expansion are Nanaimo and Bamberton. Nanaimo (Duke Point) has serviced vacant industrial land which could readily be utilized for forest products transport. Bamberton also offers vacant, abandoned industrial land, although potential industrial uses are a sensitive issue with local residents. The regional selection of port expansion or development should take account of the availability and relative environmental sensitivity of alternative sites as described in the Environmental Guide to West Coast Port Industrial Sites (Environment Canada/Ministry of Environment, 1989).

It is assumed that expanded industrial use near Cowichan Bay village would be unacceptable, given existing residential and tourist commercial uses. Some potential may exist for port expansion in outer Cowichan Bay. But there are also topographic, land use and vessel maneuvering constraints to such a site. Moreover, there may be strategic advantages to concentrating industrial use at one location

rather than dispersed industrial development and the ongoing development which it tends to stimulate.

While there is a limited supply of agricultural land in the Cowichan Valley, much of the existing land appears to be underutilized, particularly from an intensive agriculture perspective. Various arrangements are possible to acquire or lease alternative agricultural lands for development purposes.

Regional Significance

The Cowichan wetlands are a significant resource both within the context of the Cowichan Valley and the British Columbia coast.

As described in Section 3 of this study, coastal wetlands have a critical function in maintaining fish and wildlife resources throughout the Cowichan River and Koksilah River drainage. Anadromous salmon and certain trout stocks utilize the wetlands for rearing and feeding habitat. Bird populations regularly move between the freshwater marshes and the coastal wetlands on daily and seasonal basis. The wetlands are therefore an important component in the biological systems which are supported by the Cowichan-Koksilah drainage.

The Cowichan wetlands are one of the most important estuaries on the west coast of British Columbia. Unlike many other coastal systems, the Cowichan fish stocks have a large proportion of wild salmon stocks, thereby increasing their importance.

Hunter et al. (1985) have developed a rating scheme which compares British Columbia's major coastal wetlands. On the basis of waterfowl, wildlife, fish and productivity, the Cowichan rates as 10 out of a possible score of 12. On the basis of social value, imminence of development and rehabilitation/enhancement value, the Cowichan rates as 9 out of a possible score of 9. The Total Rating Value is 19 out of a possible 21. Of the 407 coastal wetlands rated, only six scored as high as the Cowichan (Somass River, Comox-Courtenay, Baynes Sound, Chemainus, Canoe Pass, Squamish).

The Cowichan wetlands have declined in size over recent decades. Prior to 1947, extensive areas were removed for agricultural purposes. Between 1947-1977,

approximately 7% of the natural estuarine area was filled (ELUCS, 1980). In recent years, 34 ha or 7% of the wetland has been restored to salt marsh.

Aquatic Resources

Fish Habitat

Fish habitat in the Cowichan estuary was rated according to criteria shown on Table 2. Using the linear relationship between area of habitat affected and habitat rating, the relative effect on habitat is estimated as follows:

	Total Habitat Rating (ha x rating)	Agriculture Dev. Impact (ha x rating)	Port Dev. Impact
Riparian	(10 ha x 5) = 50	(1 ha x 5) = 5 (10%)	-
Marsh & Pond	(18 ha x 3) = 54	(1.4 ha x 3) = 4.2 (7.7%)	-
High Marsh	(54 ha x 3) = 162	(4.6 ha x 3) = 13.8 (8.5%)	-
Mud & Sand	(173 ha x 1) = 173	-	(16 ha x 1) = 16 (9.2%)
River Channel	(42 ha x 9) = 378	-	-
Low Marsh	(32 ha x 15) = 480	-	-
Submergent Veg	(5 ha x 25) = 125	-	-
Brackish Shallow	(25 ha x 9) = 225	-	(4 ha x 9) = 36 (16%)
Total	1647	23 (1.4%)	52 (3.2%)

This analysis indicates that the agricultural development scenario would affect 1.4% of the total wetland habitat rating for fish. This involves 10% of the riparian habitat values, 7.7% of the marsh and pond values, and 8.5% of the high marsh values.

The port development scenario would result in affects on 3.2% of the total habitat rating for fish, involving about 9.2% of the mud and sand habitat value and 16% of the brackish shallow habitat.

Fish Stocks

The important fish species using the wetlands are chinook, coho, and chum salmon and steelhead and cutthroat trout. Chinook have an average annual escapement of 6,570, although this has declined by an average of 50 percent in the past six years. Coho have historically averaged 43,620 annually, but this has declined by more than 50 percent in recent years. The pattern of chum and trout species has remained relatively consistent. Chinook species are proposed to be enhanced to an escapement level of about 15,000. More limited enhancement is proposed for coho.

The potential impacts of the port expansion and agricultural reclamation scenarios could include those effects on physical, biological and social aspects of wetland functions shown on Figures 12 and 13. This includes direct habitat loss, increased sedimentation, reduced productivity and increased risks to water quality. According to the habitat rating method, 3.2% of fish habitat rating is affected in the case of port development. Given an estimated species dependence on the wetlands of 100% for chinook and chum, 50% for coho and 25% for steelhead and cutthroat trout, the port development would result in resource losses of 3.2% for chinook and chum, 1.6% for coho and 0.8% for the trout species.

In the case of agricultural reclamation, 1.4% of the fish habitat rating is affected. This would result in losses of 1.4% of chinook and chum production, 0.7% of coho production and 0.35% of the trout production.

In the case of the crab fishery in Cowichan Bay, it is assumed for the purposes of this analysis that crab populations are totally dependent upon the mud and sand, submergent vegetation and shallow water estuarine habitats (203 ha). The port development scenario (20 ha) will result in a loss of 10% of this habitat, and hence, a proportionate loss of crab harvest is assumed to occur. This is based on an assumed direct functional relationship between these critical feeding and reproductive habitats for Dungeness crabs and their population numbers.

Fishery Values

As discussed in Section 10, the commercial and recreational fishery resource losses from port development have a present value of \$1 million, while those from agricultural development are valued at \$450,000.

Wildlife Resources

Bird Habitat

Figure 9 displays the class 1 and 2 bird habitat in the Cowichan wetlands. Bird habitat was also rated for different wetland habitat types in the Cowichan, as shown on Table 3. Using the linear relationship between area of habitat affected and habitat rating, the relative effect on bird habitat is estimated as follows:

	Total Habitat Rating (ha x rating)	Agriculture Dev. Impact (ha x rating)	Port Dev. Impact
Riparian	(10 ha x 15) = 150	(1 ha x 15) = 15 (10%)	-
Marsh & Pond	(18 ha x 15) = 270	(1.4 ha x 15) = 21 (7.7%)	-
High Marsh	(54 ha x 15) = 810	(4.6 ha x 15) = 69 (8.5%)	-
Mud & Sand	(173 ha x 3) = 519	-	(16 ha x 3) = 48 (9.2%)
River Channel	(42 ha x 3) = 126	-	-
Low Marsh	(33 ha x 9) = 297	-	-
Submergent Veg	(5 ha x 15) = 75	-	-
Brackish Shallow	(25 ha x 3) = 75	-	(4 ha x 3) = 12 (16%)
Total	2322	105 (4.5%)	60 (2.6%)

This analysis indicates that the agricultural development scenario would affect 4.5% of the total wetland habitat rating for birds. This involves 10% of the riparian

habitat values, 8.5% of the high marsh values and 7.7% of the marsh and pond values.

The port development scenario could potentially result in effects on 2.6% of the total habitat rating for birds. This involves 9.2% of the mud and sand habitat values and 16% of the brackish shallow habitat.

Bird Populations

The Cowichan wetlands are an important wintering and migratory stop for large numbers of waterfowl along the Pacific Flyway. Data are not available on historical population trends. However, surveys undertaken in 1975/76 provide a conservative order of magnitude indication of bird populations dependent on the estuary:

	<u>Cowichan (229 species)</u>
Waterfowl	16,000
Water birds	2,000 - 4,000
Raptors	140
Total	18,000 - 20,000

The impacts on birds include a reduction in food sources and cover as well as disturbance to resting, loafing and roosting habitat. Applying the habitat rating model, this is theoretically estimated to potentially affect 4.5% of bird populations in the case of agricultural reclamation and 2.6% in the case of port development.

Wildlife Enhancement

Major habitat acquisition and restoration projects have been undertaken and are presently underway in the Cowichan wetlands. To date, this has involved conversion of 34 hectares of dyked backshore to saltmarsh habitat. This reflects a major investment for conservation purposes.

Recreation Resources

Recreation Habitat

Table 4 provides a rating of habitat types for recreation. This provides a simplified framework for assessing specific project development effects on

recreation. The relative effect on recreation habitat, using the assumptions described earlier, is estimated as follows:

	Total Habitat Rating (ha x rating)	Agriculture Dev. Impact (ha x rating)	Port Dev. Impact
Riparian	(10 ha x 25) = 250	(1 ha x 25) = 25 (10%)	-
Marsh & Pond	(18 ha x 9) = 162	(1.4 ha x 9) = 12.6 (7.7%)	-
High Marsh	(54 ha x 9) = 486	(4.6 ha x 9) = 41.4 (8.5%)	-
Mud & Sand	(173 ha x 1) = 173	-	(16 ha x 1) = 16 (9.2%)
River Channel	(42 ha x 15) = 630	-	-
Low Marsh	(32 ha x 3) = 96	-	-
Submergent Veg	(5 ha x 5) = 25	-	-
Brackish Shallow	(25 ha x 3) = 75	-	(4 ha x 3) = 12 (16%)
Total	1897	79 (4.2%)	28 (1.5%)

This analysis indicates that the agricultural development scenario could potentially affect 4.2% of the total wetland habitat rating for recreation. This involves 10% of the riparian habitat values, 7.7% of the marsh and pond values and 8.5% of the high marsh values.

The port development scenario could potentially result in effects on 1.5% of the total habitat rating for recreation, involving 9.2% of the mud and sand habitat rating and 16% of the Brackish Shallow habitat rating. These are of course, theoretical estimates of impacts, since it is particularly difficult to disaggregate the effects of development on the total recreation experience in the wetlands.

Consumptive Recreation Use

The Cowichan wetlands are a popular hunting area, particularly in recent years as other areas on southern Vancouver Island have been closed to hunting. There are an estimated 1500-2000 hunter days occurring in the wetlands.

The Cowichan wetlands, in their fish habitat role, also account for a large number of freshwater and saltwater sport fishing days.

The potential impact of the development projects is estimated, using the habitat rating method, to be in the order of 1.5-4% of recreation use, although actual effects could be much larger, particularly if development includes an increase in industrial traffic volumes.

Non-Consumptive Recreation

Nature-viewing and hiking activities are growing recreational uses in the Cowichan wetlands. Present recreational use is estimated at about 4200 visitor days per year. This is well below the wetland capability for recreation.

Recreation Values

The 1.5 - 4% of recreation use affected by the projects was considered too small to warrant reliable valuation.

Water Quality

Water Quality Renovation Habitat

Table 6 provides an estimate of the capacity of various wetland types to assimilate and process pollutants. Assuming that the development projects would result in a proportional loss of this capacity, the effect on water quality renovation abilities is estimated as follows:

	<u>Total Habitat Rating (ha/40 x rating)</u>	<u>Agriculture Dev. Impact</u>	<u>Port Dev. Impact</u>
Marsh & Pond	(18/40 ha x 1M) = .35 M.gal/day	(1.4/40 ha x 1M) = 35,000 gal/day	not affected
High Marsh	(18/40 ha x .8M) = 1.08 M.gal/day	(4.6/40 ha x .8M) = 92,000 gal/day	not affected
Riparian	(10/40 x .8M) = .2 M.gal/day	(1/40 ha x .8M) = 20,000 gal/day	not affected
Low Marsh	(32/40 ha x .6M) = .48 M.gal/day	not affected	not affected
Sub. Vegetation	(5/40 ha x .4M) = .05 M.gal/day	not affected	not affected
Total	2.26 million gal/day	147,000 (6.5%) gal/day	

This analysis indicates that the marginal effects of agricultural development on habitat which could serve a water quality renovation function are comparable to the loss of capacity to treat 147,000 gallons (U.S.) per day, out of an estimated total capability of 2.26 million gallons per day in the Cowichan wetlands.

Water Quality Standards

The Ministry of Environment employs working criteria for water quality as a guide to management decisions. The major water quality concern is fecal coliform. The Cowichan-Koksilah Water Management Plan (1986) states that fecal coliform levels in both the Cowichan and Koksilah Rivers exceed working criteria for shellfish located in Cowichan Bay and maximum values occasionally exceed bathing standards.

The development scenarios could result in temporary high levels of sedimentation. Some marginal effects on chemical water quality may be expected from increased industrial use and stormwater input. The agricultural reclamation project could contribute to greater coliform levels with the addition of livestock close to the intertidal areas.

Water Quality Renovation Values

The potential ability of the Cowichan wetlands to process pollutants is estimated at 2.26 million gallons (U.S.) per day. The resource losses from the agricultural development scenario have been estimated above at 147,000 gallons (U.S.) per day, comprising 6.5% of the total wetland water quality renovation capability. The economic value of this potential loss is dependent on the potential to avoid future water treatment costs at the existing facility and the likelihood of reducing coliform levels to a point where shellfish harvesting is possible.

Education/Scientific Resources

Special Ecological Features

The Cowichan wetlands provide an important resource for scientific research and education. While there is no known rare or endangered species of plants or animals in the wetlands, the relatively large size and diversity of the wetlands provides the basis for complex ecological interactions on a scale not normally present in most coastal wetlands. Such large wetlands are relatively uncommon on the coast. The fact that fish populations are dominated by wild stocks also adds to the uniqueness.

Conservation Programs

There are no ecological reserves in the lower Cowichan drainage. There is however, an ambitious program to protect and improve the wetlands. The Pacific Estuary Conservation Program has targeted the Cowichan wetlands as a top priority for acquisition and enhancement.

There is one heritage site which is affected by the agricultural reclamation scenario. It is a shallow, shell midden site on Indian Reserve No. 9, a common archaeological feature of coastal estuaries.

Land Use/Resource Management Objectives

Federal Policies

The salmon management objectives call for significant increase in the chinook stocks and marginal improvements to the coho stocks. Increased wetland alienation could jeopardize some of this enhancement effort. Federal commitments to

waterfowl management on the Pacific flyway may also be affected by wetland development.

Provincial Policies

The Cowichan Estuary Management Plan designates the proposed port development area for "future port expansion", subject to government regulatory requirements, including aspects of size and configuration.

The plan also designates portions of the proposed agricultural renovation area as "Possible Mixed Use". This latter category encourages a combination "Agriculture" and of agriculture and wildlife use, but does not specify the appropriate allocation. Agricultural development may be considered unacceptable on this site, unless appropriate wildlife mitigation is undertaken. Necessary approvals would also be required pursuant to the Heritage Conservation Act for disturbance of the archaeological site.

Community Policies

The Official Community Plan for Electoral Area F of the Cowichan Valley Regional District contains policies which state that "the use and development of areas within the Cowichan Estuary shall be in substantial agreement with the Environmental Management Plan."

12.0 DISCUSSION OF THE METHODS

12.1 Willingness-to-Pay

This study demonstrated that it is possible to obtain user and preservation willingness-to-pay values for wetlands, at least those such as the Cowichan estuary which are well known and easily accessible. For such "high profile" wetlands willingness-to-pay values can be obtained from both local and non-local residents. In order to obtain more reliable results and to include non-locals, a larger sample than selected for this study would be required. The much lower level of awareness and use of wetlands means that non-locals should be surveyed only if populations are large.

There are a number of significant problems with the willingness-to-pay method in terms of reliability and interpretation of results, including:

- possible strategic bias, particularly for some respondents who may be attempting to influence perceived planning or development decisions;
- the difficulty of attributing preservation values to a particular environment or habitat;
- the difficulty of determining the incremental reduction in willingness-to-pay values resulting from particular estuary developments;
- survey costs, particularly if non-local residents in larger population centres are to be included and if a more sophisticated questionnaire were to be developed.

With respect to specific survey techniques adopted for this study, the use of "open" willingness-to-pay questions is considered to have been successfully tested. However, it is unclear whether the unrealistic high estimate of estuary use obtained through random sampling is the result of inherent bias in the method or the small sample size. In any case, survey methods might be altered depending on specific circumstances. For example, if study resources were very limited, a user group survey might be undertaken instead of a more costly random survey. A pre-test of utilization, as done for this study, would be useful to determine if the level of use by non-locals is significant enough to warrant surveying.

It should be noted that a survey of wetlands users may not capture recreational values in non-wetlands locations which could be at least partly attributable to the wetland. This is particularly important in the case of migrating salmon taken in non-estuary fisheries. Data on non-estuary commercial harvest, recreational effort and values must be obtained independently. Conversely, it could be argued that consumptive values for wildlife in the wetland area at least partly dependent on other habitats. In this study, such values are assumed to be entirely attributable to the estuary.

With respect to preservation value, estimates may be useful for some planning purposes (e.g., assessing the regional significance of different wetlands). However, because of difficulties in determining the validity and consistency of preservation values, it is recommended that they be used with caution in quantifying wetland values.

12.2 Opportunity Cost

In this study, wetland preservation benefits are defined as the opportunity cost of, or contribution to society foregone by wetland development minus the opportunity cost of preservation. The opportunity cost of wetland development is the sum of market and non-market values precluded by this development. Willingness-to-pay estimates simulate values for recreational activities supported by the wetland for which market prices do not exist. Resource losses such as commercial fisheries are estimated directly on the basis of market values. The opportunity cost of estuary preservation is estimated as the net economic loss associated with relocating proposed developments.

The application of the willingness-to-pay method is discussed in Section 6.1. The estimation of resource losses for which market values exist is straightforward methodologically but is subject to the availability of data, particularly with respect to incremental biophysical impacts of wetland developments. The habitat rating system applied in this study is a useful means of assessing incremental development impacts. If baseline data do not exist, the costs of compiling such information may be prohibitive for project-specific assessments.

The effort and practicality of measuring the opportunity cost of wetland preservation depends on the availability and nature of alternative non-wetland sites. If there is a very similar, readily available site, the cost of relocating may be negligible or easily measured as, say, differences in transportation and land acquisition costs. At the other extreme, alternative sites may be so different as to require re-design and costing of the entire project.

The incorporation of both existing and potential wetlands values was recommended and applied in this study. Theoretically, potential values should be adjusted by their probability of occurrence. However, in practise, only those potential values which

are associated with firm commitments (e.g., resource enhancement programs) should be considered. One other issue which is very important in the application of benefit-cost analysis, but beyond the scope of this study, is the choice of the rate at which future values are discounted. For commercial development, including those in wetlands, a real discount rate should be used which is representative of an average rate of return on business investment elsewhere in the economy. Current estimates of this rate of return are in the order of 8%. For environmental resources, which are a form of consumer good, it could be argued that a lower time preference rate in the order of 3% - 5% would be more appropriate. These rates reflect the interest premium individuals must be paid to persuade them to defer consumption. They are usually estimated on the basis of the return on individual, long term savings such as bonds. Use of a lower discount rate significantly increases the present value of renewable, wetland resources. It is suggested a discount rate for wetland evaluations be developed based on a review of theoretical literature and federal Treasury Board guidelines for benefit-cost analysis.

12.3 Cumulative Assessment

The cumulative assessment framework developed by the Wetlands are Not Wastelands program presented some difficulties for measuring the marginal effects of development proposals. Moreover, the framework did not sufficiently provide a basis for considering the accumulation of impacts over time and space. The goals, objectives, and standards for environmental and land use management were not in themselves precise enough to serve as evaluation criteria.

In order to supplement the cumulative assessment approach, a habitat rating method was developed which provided a theoretical basis for considering change in relation to the overall supply and capability of wetland habitat and for linking the impact on habitat to loss of wetland products and wetland values. The limitations of this method are noted in the report, particularly the simplistic assumption of linear relationships between habitat and wetland functions and products. The advantage of the method is that it provides an approximate indication of effects on the overall supply and relative quality of wetland habitat. Additional problems related to the wetland classification which did not include "agriculture" as a wetland habitat, although some of the agricultural land included in the development proposal was marginal land which is seasonally inundated, and which contributes to the

productivity of the estuary. The effects of changing this marginal agricultural land to full agricultural production were difficult to measure, and were not incorporated into the habitat rating system.

Effort was also made to present data on the historical levels and potential future levels of resources generated by the wetlands. The incremental degradation of wetland habitat needs to be considered in context with historical conditions and future opportunities. In the Cowichan case, however, the lack of readily available data limited somewhat the ability to consider the temporal context of incremental development.

Figure 14 summarizes the major conclusions of the cumulative assessment method. The cumulative assessment approach proposed by Environment Canada provides a useful means of compiling and presenting descriptive information on overall wetland attributes. But the use of general criteria and the lack of a structured evaluation process clearly limits its potential for assessing the impact of development. The value of the method lies in its ease of preparation and adaptability to wetland features. It can serve as a useful goals evaluation matrix to assist local planners in presenting a wide range of wetland data. This role should be distinguished from a scoped, technical impact assessment which traces cumulative impacts through physical, biological and human systems.

13.0 CONCLUSIONS AND RECOMMENDATIONS

13.1 CONCLUSIONS

The controversies surrounding incremental alienation of wetland habitat in the Cowichan estuary, and various other coastal wetlands in British Columbia, attest to the need for more effective methods for evaluating wetland functions and values. Biological uncertainties and data deficiencies, however, present major constraints to the evaluation of incremental changes to wetlands. In this study, three methods were tested in the Cowichan estuary wetlands: willingness to pay, opportunity cost and cumulative assessment.

Table 10: Summary Matrix

<u>Criteria</u>	<u>Port Development</u>	<u>Agricultural Development</u>
1. Economic Viability	- Viable but minor opportunity costs of preservation	- not economically viable
2. Site Alternatives	- Nanaimo & other alternatives available	- nearby underutilized land available
3. Regional Significance	- ranked 19 out of a possible score of 21; within top 6 of 407 coastal wetlands	
4. Fish Habitat	- 3.2% of total rating affected	- 1.4% of total rating affected
5. Fish Stocks	- 3.2% of chinook & chum 1.6% of coho & 0.8% of trout affected	- 1.4% of chinook & chum 0.7% of coho & 0.35% of trout affected
6. Fishery Values	- est. loss of \$82,000 annually	- est. loss of \$36,000 annually
7. Bird Habitat	- 2.6% of total rating affected	- 4.5% of total rating affected
8. Bird Populations	- existing counts of 18-20,000 birds & 229 species are below historical levels.	
9. Wildlife Enhancement	- major investment in habitat acquisition and enhancement	
10. Recreation Habitat	-1.5% of total ranking affected	- 4.2% of total ranking affected
11. Recreation Use	- hunting activities = 1500 - 2000 days/yr - sport activities = 4700 days/yr - wildlife viewing = 4200 days/yr	

- | | | |
|---------------------------------|--|---|
| 12. Water Quality
Renovation | - renovation capacity
unaffected | - 6.5% of total
renovation rating
affected |
| 13. Water Quality
Standards | - increased
sedimentation
& chemical risks | - potential increases
in fecal coliform levels |
| 14. Conservation
Programs | - potential conflict
with wildlife conservation
program | - 1 heritage site affected |
| 15. Management
Policies | <ul style="list-style-type: none">- Federal salmon enhancement & management
programs affected- Federal responsibilities for Pacific Flyway are
affected- Provincial policies require a detailed impact
assessment- Official Community Plan endorses conservation of
wetlands. | |

It was recognized at the outset, that development proposals chosen for analysis in this study should be consistent with the Cowichan Estuary Management Plan. The Plan provides definite limits on the type and location of projects which might be deemed acceptable in the estuary. Accordingly, two hypothetical potential development scenarios were identified: a port development project located within an area designated as "potential port expansion" at the outer edge of the estuary, and, an agricultural development project located within an area designated for "possible mixed use" and "agriculture" at the upper edge of the estuary.

A wetland habitat rating system was developed which provided a framework for assessing the impacts of the development scenarios on the physical and biological attributes of the wetland. This framework provided quantitative estimates of the potential marginal effects of development on wetland products (fish, wildlife, recreation, water quality) for use in the economic and cumulative assessments.

The habitat rating system used in this study is a highly simplified method of assessing the wetland environment. It assumes a linear relationship between wetland habitat effects and loss of wetland products. It also assumes that wetland functions and their products can be compartmentalized into different habitat types. Moreover, the assumption is made that future production levels can in fact be reliably estimated. Despite these gross assumptions, the rating system provides an approximate assessment of the distribution and relative importance and value of wetland habitat, against which the effect and site suitability of specific proposals for wetland development can be evaluated.

In the view of the study team, the willingness-to-pay and opportunity cost methods should not be regarded as mutually exclusive evaluation alternatives. Rather, both should be incorporated in social benefit-cost assessment of wetland developments. Social benefit-cost analysis is a recognized analytical method used to systematically evaluate and compare the social worth of alternative projects or courses of action. Willingness-to-pay values represent the non-market subset of the opportunity costs of wetland development. Measuring and comparing the opportunity cost of wetland preservation (i.e. project relocation costs) with the opportunity costs of development (i.e. resource and recreation losses) provides decision-makers with a quantitative

or qualitative comparison of the relative merits of wetland development versus preservation.

Benefit-cost analysis has two major limitations when applied to wetlands. Firstly, there is the well-known difficulty of attaching dollar values to resources and activities. Secondly, the cumulative nature of wetland alienation is not adequately addressed. Therefore, the study team is of the opinion that both economic values and environmental criteria are necessary to provide wetland planners and government decision-makers with the full range of information necessary to properly evaluate the implications of wetland alienation or enhancement.

The cumulative assessment provided an evaluation of development in relation to nine sets of criteria which incorporate various biophysical and socioeconomic data. This assessment included quantitative estimates of the effects of development on the overall supply of rated wetland habitat, the products theoretically generated from that habitat, and the economic values derived from these products. Other, more qualitative evaluations were also provided, based on a variety of indicators of the societal goals and values associated with the Cowichan wetland.

Cumulative assessment can also be viewed as a "multiple accounts" framework (similar to the DFO salmonid enhancement (SEP) assessment approach), possibly including a habitat account, a biological account, a socio-economic account, each with their own evaluation criteria. The accounts should be designed to consider the significance of marginal changes in wetland, and include accepted procedures for benefit-cost analysis. Standardized databases could also be established for wetlands to provide a ready-made basis for applying cumulative assessments.

There are a number of specific issues with respect to application of evaluation methodologies which depend on the nature of the wetland and development being considered. Key factors which will determine the specific approach are the availability of data and the resources available to wetland managers. Over the years, a relatively thorough data base on wetland resources and activities have been developed on the Cowichan estuary. Data were not as readily available for the other wetland pilot projects and this is likely to be the case for most wetlands. This hampers and increases the costs of evaluating wetlands.

13.2 RECOMMENDATIONS

The following recommendations are offered for the practical application of the wetland evaluation methods in other wetlands in Canada.

First, regardless of the scale of study resources available, it is important that the evaluation process be as efficient as possible. A screening phase could be useful whereby projects would be subject to progressively detailed assessment as the project warrants. The first step in this process would be to determine the opportunity cost (ie. the value to society foregone) of estuary preservation. If the opportunity cost of wetland preservation is zero, ie. if development projects are clearly not economic or have an equally viable alternative location, then further detailed evaluation is unnecessary.

Secondly, there is a need for a structured method, such as the habitat rating method developed in this study, in order to address the marginal aspects of incremental wetland alienation and degradation. Such a method could be refined through more detailed assessment of key wetland components and functions to improve the habitat rating process. As an adjunct, the habitat rating system could be further improved through the use of ecosystem modelling. Once an acceptable habitat rating system is established, the actual application of the method can be easily applied in a cost effective manner. It is important however, that the limitations and purpose of the method be clearly recognized. The method should also be applied as part of a wider evaluation framework and a thorough project review process.

Thirdly, the cost of economic assessment may be reduced by undertaking willingness-to-pay surveys only periodically for various types of wetlands in various parts of Canada. The values derived in these surveys could be updated annually with an appropriate price index. Another, even less costly approach would be to use willingness-to-pay values already estimated by other planning agencies for recreational activities similar to those undertaken in wetlands. Data on wetland products or activities would still have to be collected for the specific wetlands being evaluated.

Finally, wetland management plans and policies which establish objectives to counter the incremental loss of habitat and other wetland degradation, are an important complement to wetland evaluation techniques. Specific methods such as those tested in this study can provide a means of formulating policies in advance of specific development proposals. More rigorous and standardized methods and criteria are required in order to develop and implement objectives for the use and management of wetlands.

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APPENDIX 1
WILLINGNESS TO PAY SURVEY QUESTIONNAIRE

Hello. I'm calling from Horizon Research. We're conducting a study for the Canadian Wildlife Service to find out people's ideas about the Cowichan River estuary. Your phone number was randomly selected for our sample.

In your household, I need to speak to (_____) who is at home. Who would that be? [if not respondent.] Could I please speak to him/her? (an adult)

[If new respondent, repeat opening para.]

The questions take about five minutes. OK?

1. First, are you familiar with/aware of the "Cowichan River estuary? - [the wetland area at the mouths of the Cowichan and Koksilah Rivers (the boundaries of the area would be Khenipsan Road on the north; Tzouhalem and Cowichan Roads on the west and south; and the eastern edge of the mud flat and Western Forest Products Port)?]

2. Do you ever visit or use the Cowichan estuary?

[IF NO, GO TO QUESTION 5]

3. What kinds of activities do you do there (within the boundaries, i.e. not out in the bay)? (prompt if necessary):

- A. Watch the birds and/or wildlife
- B. Fish
- C. Hunt
- D. Other (specify) (if any of A-C also involved, indicate by number)

4. And how many times in the past year have you visited the wetlands to:

[READ ONLY THOSE IDENTIFIED IN #2 ABOVE]

- A. Watch the birds and/or wildlife
- B. Fish
- C. Hunt
- D. Other (specify)

*contact for further info in survey: Neil Dave , Qualicum Wildlife Centre.

5. We're trying to find out what recreational value people place on the estuary. We want to be able to compare its current value with the value it might have if it were further developed for industrial or other uses. To estimate its current value, we need to ask you some questions about the value - in dollars and cents - that it holds for you. (Please keep in mind that these are hypothetical questions - your answers will be used for research purposes only.)

I'm going to ask you what value you would place on one day or visit (MOST FREQUENT ACTIVITY FROM #3) in the wetlands. To help you get a frame of reference, you might keep in mind that:

- o a day of cross-country skiing at a commercial facility would cost about \$5.00 (downhill - \$22.00)
- o a round of golf costs approximately \$8.00 - 9 holes, \$12.00 - 18 holes.
- o a day at the waterslides would cost \$10.95 - adult, \$10.95 - child > 11yrs., \$7.95 - 4-7 yrs.
- o B.C. Forest Museum - \$3.50 adults, \$2.50 seniors/students, \$1.50 children.
- o movies - \$5.00 adults, \$4.50 - 12-15 yrs., _____ children.
- o bowling - \$6.00/person for 2 hrs. (an evening)
- o swimming - \$2.25 adults, \$1.50 children.

So, what value would you place on one (ACTIVITY NAMED ABOVE) trip/visit to the Cowichan estuary?

6. Imagine that some non-profit group established a fund to preserve the wetland area. Think about its value, not in terms of your current use, but "so it will always be there" for your children and grandchildren. It would also be a refuge for wildlife, protection for endangered species, and a rearing habitat for fish.

How much would you be willing to contribute annually to a fund that would preserve or purchase the Cowichan estuary?

7. For statistical purposes - to make sure that we have talked to a representative sample of people in your area - I need to find out which of the following age groups you fall into:

- A. 19-34
- B. 35-49
- C. 50-64
- D. 65+

Thank you very much for your help.